CIVIL ENGINEERING

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Big Bend, Where the Colorado River Cut a New Channel in 1906
Completion of Boulder Dam Prevents Recurrence and Protects Vast Farm Lands in Imperial Valley

Volume 5 — AMERICAN SOCIETY OF CIVIL ENGINEERS FOUNDED 1852 — Number 5

MAY 1935

Among Our Writers

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T. T. WILEY, who has degrees of bachelor and master of science from the University of Illinois, has had a responsible part in the development of the methods, analyses, and reports of the Illinois traffic survey conducted by the Ottawa district office of the Illinois Division of Highways. He is now with the Bureau of Maintenance at Springfield, Ill., which has recently been given jurisdiction over traffic survey activities.

PHILIP B. BUCKY received degrees in mining from the University of Illinois, 1921, and Pennsylvania State College, 1926, and took up mining engineering in the field before becoming assistant professor of mining, first at Pennsylvania State College and since 1929 at Columbia University.

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Significance of Boulder Canyon Project

Considerations Leading to Vast Undertaking for Regulation, Water Supply, and Power

By WALKER R. YOUNG

MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
CONSTRUCTION ENGINEER, BUREAU OF RECLAMATION, BOULDER CANYON PROJECT, BOULDER CITY, NEV.

"UNTIL settlement reached the borders of the arid region, public land in the humid section was the door of opportunity for the restless and enterprising. But when the wave of settlement reached the arid zone, pioneers had to deal with new conditions and were confronted with new problems. Homes and civilization were limited, not by land, but by water.... Irrigable land became, therefore, the new frontier and is so today. Private and district enterprises were able to build the simple channels which carry water to the valleys bordering streams, but when it became necessary to divert and control rivers and when storage of floods became a fundamental requirement, some agency with greater resources and with a continuity of policy which would reach beyond the limits of a single state was essential. Out of this need the reclamation fund and the Bureau of Reclamation were established."

These words of Elwood Mead, M. Am. Soc. C.E., form an admirable introduction to Mr. Young's paper covering the various reasons—political, economic, and engineering—which pointed to Boulder Dam and its vast associated enterprises as the best solution of a great national problem. The original of this paper was presented by Mr. Young before the meeting of the California Farm Bureau Federation in Los Angeles on February 27, 1935.

TO grasp the significance of Boulder Dam, one must understand the relation of the Colorado River to the settlement and economic development of the 244,000 sq miles of the drainage basin, comprising parts of seven states and a very small part of Mexico. Eighty per cent of the flow originates in the lofty snow-capped mountains of the two states of Wyoming and Colorado, ranging upward to elevations in excess of 14,000 ft above sea level. This is the source of the turbulent summer floods resulting from the melting of deeply packed snow and ice. The Colorado River basin is shown in Fig. 1.

Through its lower course, the Colorado flows across the hottest and dryest part of the United States, finally discharging into the northerly tip of the Gulf of California. There are places where the annual precipitation is only 3 in., where no rain falls in summer, and where the existence of civilized life depends on ability to utilize the water of this river.

In ages past, what is known as the Gulf of California is said to have extended in a northerly direction to a point where the town of Indio, Calif., above Salton Sea (Fig. 2), is at present located. But as a result of the deposition of sand and silt, large quantities of which are continually carried by the river, a delta was built that finally extended across the gulf. Subjected to the intense heat of the sun and the strong drying winds of the locality, the water to the north evaporated, leaving what is now Imperial Valley and a remnant of the ocean, Salton Sea, with its surface lying 250 ft below mean sea level. It did not take long for civilized man to seize upon the opportunity to irrigate the rich marginal lands of Imperial Valley with water obtained by gravity from the Colorado River, and soon the valley became a rich farming community. Along with this development came the settlement of other valleys higher up on the river.

FIGHTING THE COLORADO

Unfortunately, floods and the silt-carrying proclivity of the Colorado River introduced serious problems for those making use of the land and water. To protect those lands lying below the elevation of the river, levees were required to confine the river to its channel. Each year the river, with its heavily silt-laden floods, debauched on the lower valleys, tearing at the leeves in its mad effort to find means of escape to lower lying lands. Man retaliated by building his levees higher and stronger.

Failing to escape the levees, the river deposited the silt in its own channel in an effort to lift itself over the leeves—to attack and destroy what man had been able to establish. The fight went on. Leeves were breached; fields were destroyed; irrigation ditches were filled with silt; levees were raised; ditches were cleaned; crops were replanted; and new basins were developed in which the river could deposit its silt, until finally the defensive measures became so costly as to be oppressive. The river provided an ever-present menace, and man was brought to realize that the only possible way to win his fight against it was to put it under control and thereafter make it his servant.

Without regulation, the river had little value to the lower basin area. The quick run-off and the absence of summer rains made any large irrigation development, or any large power development, uncertain and unprofitable, and the river could not be depended upon as a source of water supply for cities. Without storage facili-

WHERE THE DESERT BLOSSOMS—IRRIGATED LAND IN IMPERIAL VALLEY
Left, Cotton Farming. Right, Canteloupes by the Hundreds of Acres, One of the Largest Single Garden Crops in Imperial Valley. In 1926 the Stupendous Total of 16,000 Carloads of Canteloupes Was Shipped Within Six Weeks

ties, further development by irrigation was not feasible, and in fact more land had already been canalized than could be irrigated by the natural flow of the river during periods of low discharge. Regulation of flood waters by storage was therefore seen to be the basis of all safe and profitable development.

COLORADO REGULATION A PROBLEM

Regulation of the Colorado River requires a reservoir, or reservoirs, with sufficient capacity to equalize the variations of flow between seasons, and also the variations in discharge over a long period of time. Such regulation is imperative because at present nearly 800,000 acres of irrigated land and the homes of 100,000 people are dependent on diversions made in the vicinity of Yuma, and because of the rapid extension of irrigation in the Imperial Valley in California, and in southwestern Arizona. These factors have created a demand for water greater than the low-water flow of the river.

This demand for a secure water supply and protection against flood menace compelled the attention of the Federal Government and resulted in the construction of Boulder Dam. Thus not only the main objectives of flood control and irrigation are realized, but also other advantages accrue. Among these are the reduced cost of removing silt and the increased supply of pure water for the growing population of the cities and towns of Southern California and the orchards and gardens that surround them.

Much study, and the collection of a large amount of field data were required to determine the proper—or at least a logical—solution of the problem. These investigations were undertaken by the Bureau of Reclamation in 1904. The area tributary to the Colorado River is divided roughly into an "upper basin" and a "lower basin" at Lee's Ferry, Ariz., a few miles south of the point where the river enters Arizona from Utah. These two basins are of about equal area and are separated physically and climatically by what is generally referred to as the "canyon section." Immediately below Lee's Ferry the river enters a bottleneck. For approximately 400 miles it flows through a precipitious canyon country, then leaves it to enter the agricultural areas of the lower basin. The upper basin includes the drainage area in the states of Wyoming, Utah, Colorado, and New Mexico, while the lower basin includes the drainage area within the states of Nevada, Arizona, and California.

To form a comprehensive plan of development, data were required from both sections of the river. These investigations indicated that the most suitable reservoir sites in the upper basin were Flaming Gorge on the Green River, with a capacity of 4,000,000 acre-ft, the Juniper on the Yampa River, with a capacity of 1,500,000 acre-ft, and the Dewey, on the Grand River (now

FIG. 1. COLORADO RIVER BASIN, WITH PRINCIPAL RESERVOIR SITES

CATASTROPHE FOLLOWS BREAKS IN LEVEES ALONG THE LOWER COLORADO IN 1906
Left, Railroad Tracks Form Suspension Bridge as Flood Cuts New Channels; Right, How the River Cut Into the Imperial Canal Near the Five Headings

named Colorado) with a capacity of 2,270,000 acre-ft. None of these reservoirs was large enough to serve as a regulator of the river's flow. They were too remote from the place where regulation was most needed. Also, in the case of Flaming Gorge, its use as a storage reservoir for irrigation would seriously interfere with its great value as a power site.

In the lower basin the choice narrowed down to a large reservoir located at the upper extremity of the basin in a position to control the entire situation, the dam site to be either in Boulder or in Black Canyon. Black Canyon was finally selected as the better site, principally because of economic advantages. Here it was found possible to build a dam that would create a reservoir large enough to hold the entire flow of the river for two years. Such a dam, being located below the large tributaries, would permit of an effective regulation of floods. The dam site is near enough to the great power markets of Southern California to make transmission of electrical energy feasible and is in the center of a mineralized country in Nevada and Arizona, in which cheap power would be a great aid to the development of natural resources.

EQUITABLE DIVISION OF WATER DEMANDED STUDY

During the time the engineering features were being investigated, thought was also being given to the legal phases, with particular reference to an equitable division of the water. In litigation it had been assumed that the river and its tributaries carried annually an average of about 18,000,000 acre-ft of water; that about half of this had been put to beneficial consumptive use; and that the remainder was flood water for the use of which storage facilities were necessary.

It was inevitable that on so extensive a river system, flowing through arid country, the seven states involved should disagree over their respective water rights. In 1922, when they undertook to settle these problems, it was estimated that about 2,127,000 acres of irrigable land lay in the lower basin and about 4,000,000 in the upper basin, and that of these areas, the lower basin contained approximately 1,165,000 acres awaiting development and the upper basin about 2,500,000 acres.

For a number of years prior to 1922 the lower basin, growing more rapidly in population than the upper area, had pressed for development of the lower Colorado River, and the upper area had objected. Two lower-basin projects particularly were urged. One was the development of the Imperial Valley, lying below the level of the river, which needed relief from floods through the erection of a flood-control dam, and which also needed an all-American water supply in lieu of its existing canal, which passed through, and was largely controlled by Mexico. The second project, presented by interests of the California coastal plain, called for the erection of a power dam at Boulder Canyon or Black Canyon.

BILLS INTRODUCED FOR ALL-AMERICAN CANAL

In 1919 a bill had been introduced in Congress for Federal assistance in building the All-American Canal, and again in 1920 a similar bill had been introduced. In April, 1922, a third bill had proposed not only the building of the All-American Canal, but also the construction of a storage dam on the main trunk of the river below the mouth of the Green River. In the meantime, Arizona was formulating projects of her own, particularly those calling for the irrigation of a large area on the Gila River and some territory in the vicinity of the town of Parker on the Colorado.

It was rapidly becoming apparent that the normal flow of the river would not be adequate to supply all the uses demanded by the upper and lower basins; but the proposals for storage in the lower basin, without guarantees to the upper states, were regarded by the latter as holding the threat of establishing priorities, which would preclude later use of the water in the upper division of the area concerned.

Crystallization of issues was a slow process. The various states approached the problem individually, and the conception of a division of the water as between the two basins, instead of as among the individual states, was not an immediate development. Within each of the states there were of course conflicting claims by various projects. But the common desire for a solution gained headway. In 1920, at a meeting of representatives of governors of western states, Delph E. Carpenter of Colorado made a novel proposal for the use of the treaty-making powers of the states. This was endorsed, and as a result of the approval which the governors gave of this proposal for an interstate compact, the legislatures of each of the seven states authorized the appointment of commissioners. The governors designated Governor Thomas E. Campbell of Arizona to bring their request for Federal participation to the attention of Congress. When this was done the state legislatures and Congress

THE COLORADO IN FLOOD
Scene Near Yuma, Ariz., in January 1916

authorized an agreement, and commissioners were appointed.

The members of the original Colorado River Commission were:

Arizona	W. S. Norviel
California	W. F. McClure, M. Am. Soc. C.E.
Colorado	Delph E. Carpenter
Nevada	J. G. Scrugham
New Mexico	Stephen B. Davis, Jr.
Utah	R. E. Caldwell
Wyoming	Frank C. Emerson, M. Am. Soc. C.E.

On behalf of the United States, the commission was presided over by Herbert Hoover, appointed by President Harding. After a series of meetings in Washington, D.C., and at various places in the Colorado River watershed, the Colorado River Compact was signed by representatives of the seven states on November 24,

BOULDER DAM SITE FROM THE RIVER, LOOKING DOWNSTREAM (1931)

1922. Among other things, it adopted Lee's Ferry as the point of division between the upper and lower basins and effected an allocation of water between the two basins, leaving to future adjustment the division of water within each basin. The compact was later ratified by each of the interested states except Arizona. Controversy between Arizona and the other states gradu-

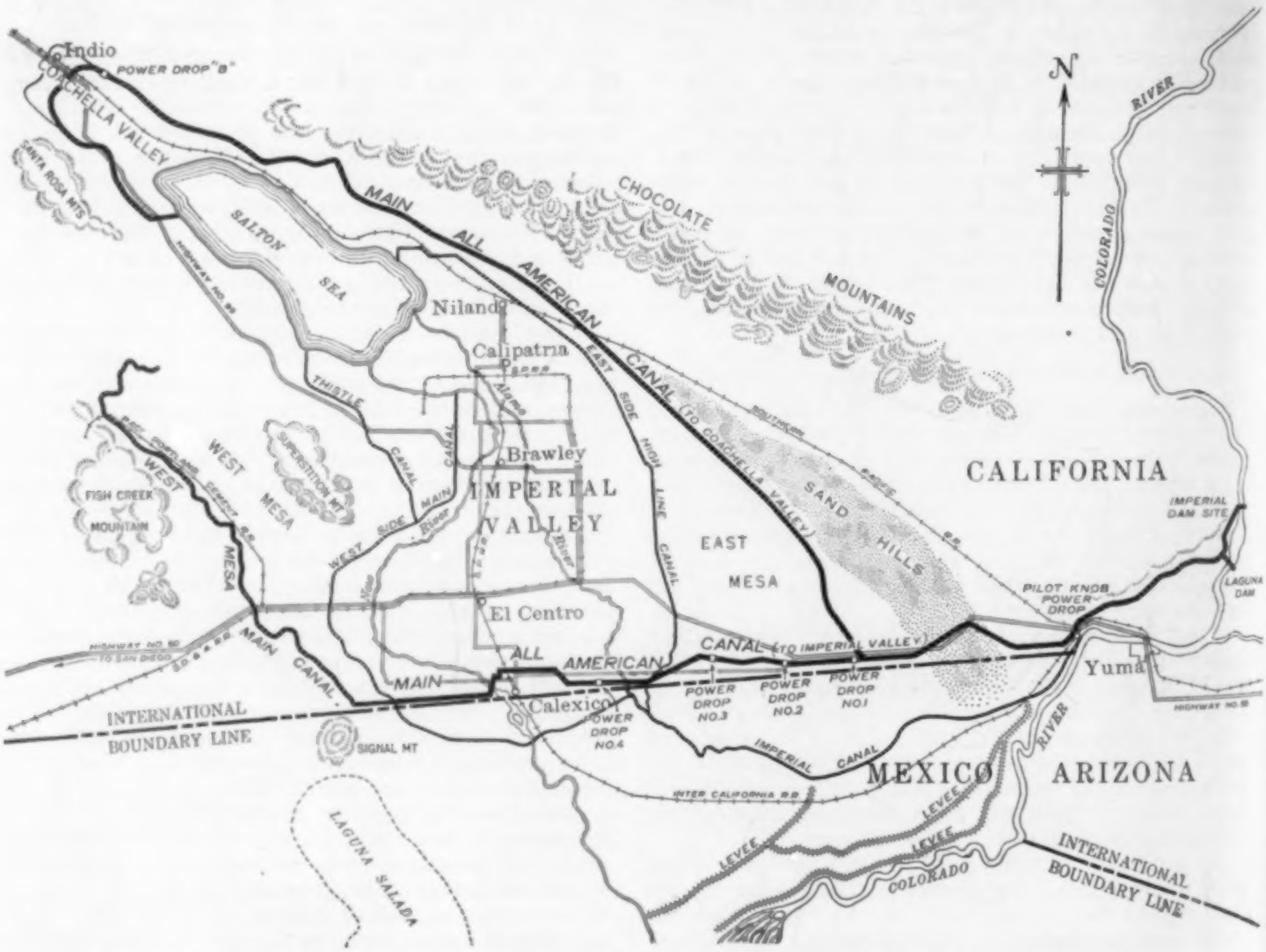
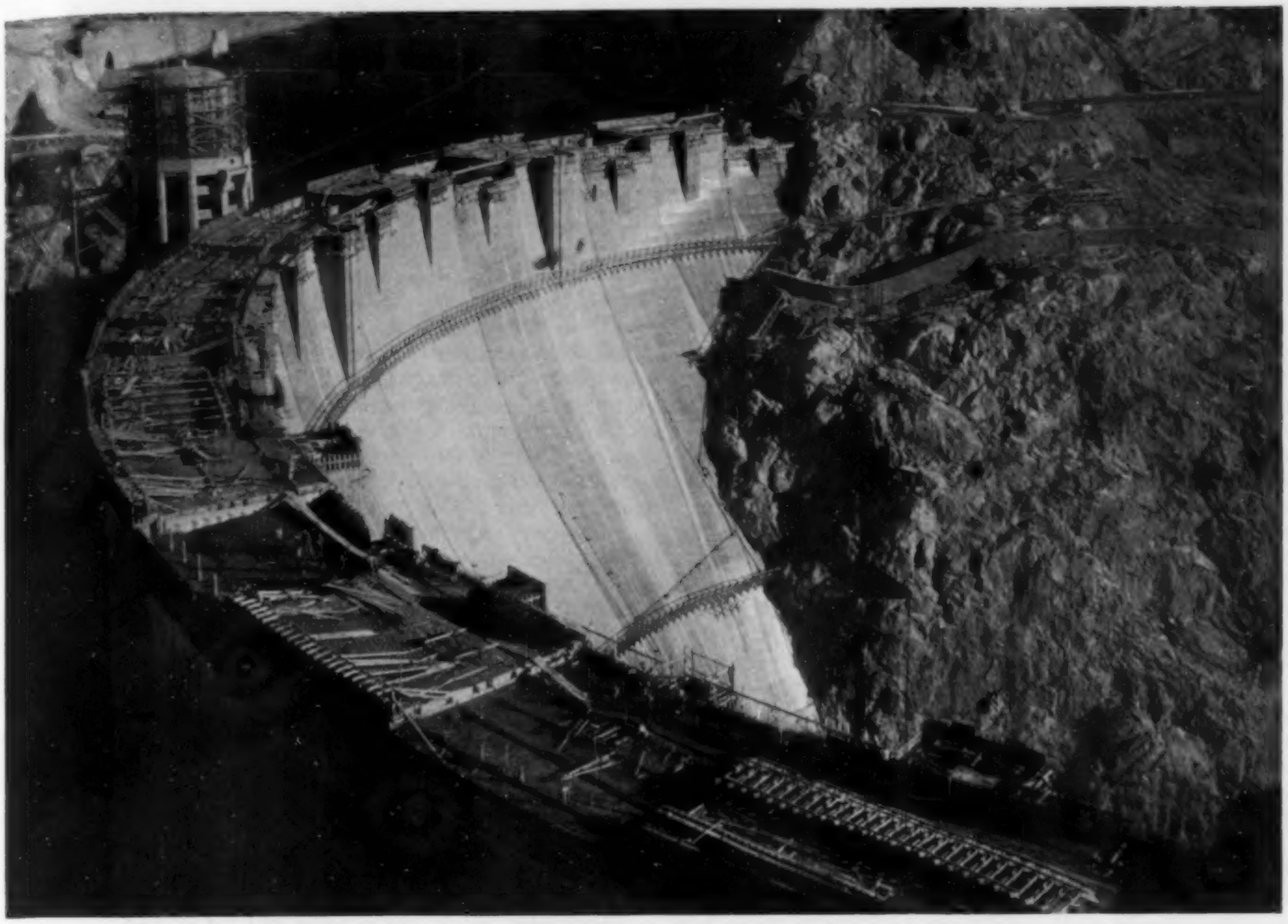


FIG. 2. IMPERIAL VALLEY AND THE ALL-AMERICAN CANAL, SHOWING ALSO THE OLD IRRIGATION CANAL SYSTEM



Boulder Dam Reaches Full Height
Work on Crest as Seen from Nevada Side in February 1935

ally crystallized on issues involving the relationship of the Gila River in the apportionment proposed by the compact. The compact, having been ratified by six of the seven states, was finally submitted to Congress for approval some five years after its execution, without awaiting Arizona's further action.

THE BOULDER CANYON PROJECT ACT

All these developments preceded the enactment of legislation by Congress authorizing construction of the Boulder Canyon Project. The Boulder Canyon Project Act, commonly referred to as the Swing-Johnson Bill, became a law December 21, 1928. As finally passed, this act established, among other things, three major objectives:

1. The Colorado River Compact was ratified, and provision was made that in the event only six states should ratify it, the compact should become effective as a six-state compact, provided California was one of the adhering parties, and provided further that California should agree to limit her use of water to the benefit of the other six states.
2. The construction of a dam at Black Canyon or Boulder Canyon was authorized.
3. The construction of an All-American Canal connecting the Imperial and Coachella valleys with the Colorado River was authorized. For the construction of these two works, the expenditure of a total of $165,000,000 was authorized.

Authorization for the dam (subsequently located at Black Canyon) required that the structure be used, first, for river navigation and flood control; second, for irrigation and domestic purposes and the satisfaction of present perfected rights; and third, for power.

The act established a unique method of financing the construction of the dam. A special fund was established, designated as the Colorado River Dam Fund, which bears somewhat the same relation to the Treasury as a subsidiary does to a parent corporation. The act authorizes the transfer from the Treasury to this fund of $165,000,000, to be repaid with interest at 4 per cent.

One of the conditions precedent was that the Secretary of the Interior make provision for revenues by contracts adequate, in his judgment, to insure payment of all expenses of operation and maintenance and the repayment, within 50 years after the date of completion of the works, of all amounts advanced to this fund, with interest made reimbursable under the act. Two classes of contracts relating to the use of Boulder Dam are provided for: contracts for electrical energy and for the storage and delivery of water. To date the Secretary of the Interior has executed eight power contracts and two water contracts. He has approved as to form three additional water contracts and two contracts for repayment of the cost of diversion dams. He has also approved an Arizona water contract in the form of regulations.

With this background and for these ends the tremendous Boulder Dam Project was initiated—the greatest of its kind in imagination and scope. A brief review of its historical antecedents should thus enable Americans to appreciate more keenly its key position in the solution of many important problems.

Cost of Passenger Automobile Stops

Obtained from Tests on Cars of Various Weights and at Wide Ranges of Speed

By T. T. Wiley

Junior American Society of Civil Engineers

Junior Highway Engineer, State Division of Highways, Bureau of Maintenance, Springfield, Ill.

ONE of the factors of highway travel assumed or ignored—but certainly not previously investigated as far as Mr. Wiley knows—is the expense incident to normal stops of automobiles. In these days of increasing traffic regulation, the stops are gaining in number and importance. His investigations therefore utilized four passenger cars from 2,300 to 3,800 lb in weight, at speeds from 10 to 60 miles per hr. By consistent manipulation, including identical test routine and runs in both directions, inequalities were minimized. The results have been reduced to cost of gasoline per stop and to equivalent mileage at uniform speeds. Finally, total costs have been derived, varying from 0.15 cent per stop at moderate rates to 0.25 cent at higher speeds. These data should prove valuable in future traffic investigations and also as a basis for the design of highways.

EVERY student of highway economics and most automobile owners living in cities realize that it costs more per mile to operate an automobile in urban traffic than it does at normal speeds on improved rural highways. The major reason for this difference is universally assumed to be the incessant starting and stopping required for safe movement through a city. Considering that this cost differential and the reason for it are so generally accepted as facts, it is startling to find that data on the cost of stops are practically non-existent and that this item of cost is usually overlooked or else given minor consideration in the design of city and rural highway improvements and in traffic regulations.

A few references, however, have been found. For example, in *Highway Economics* by Sigvald Johannesson, M. Am. Soc. C.E., a cost of 0.1 cent per stop is derived by a theoretical analysis based on the loss of kinetic energy. Although this derivation is questionable from several standpoints, it is at least an approach to the problem. Again, C. C. Wiley, M. Am. Soc. C.E., in his *Principles of Highway Engineering* estimates that a stop is equivalent to one-eighth of a mile of uninterrupted running, but he erroneously applies this ratio to the total of all items of car costs instead of including only the operating costs. Neither of these writers had any factual data on which to base his assumptions.

In order to obtain definite data I undertook in 1931 to determine the actual amount of gasoline consumed in making stops. In spite of limited time, facilities, and finances, significant results were obtained. In 1933, D. M. Baldwin supplemented the earlier work with similar tests on newer cars. The results of the two groups of tests are combined in this article. It is to be noted that the word "stop" is used to designate the entire procedure of bringing the machine to a halt from a definite speed, and then accelerating to the same speed.

Four passenger cars in good mechanical condition were used, as listed in Table I.

Table I. Passenger Cars Used in Tests

Designation	Type	Year	Cylinders	Brakes	Weight in Lb
A	Touring	1923	6	2-wheel	3,800
B	Coupe	1927	4	2-wheel	2,300
C	Sedan	1931	6	4-wheel	3,120
D	Sedan	1933	8	4-wheel	2,950

In addition, a 1931 eight-cylinder sedan of fairly heavy weight was included in the original series, but an irregular tendency for the fuel pump to overcarry and flood the carburetor while stopping rendered the data invalid.

The test car was equipped with two 5-gal oil cans to be used as measuring tanks. They were provided with stopcocks and compression fittings for $^5/_{16}$-in. copper tubing. In Cars A and B, which were equipped with vacuum tanks, the tubing from the measuring tanks was connected just before the fuel line reached the carburetor in such manner that gasoline could be used from either of the measuring tanks or from the vacuum tank. In the test runs, gasoline from either special tank was used as convenient, while the vacuum tank was utilized for incidental movements.

Cars C and D were equipped with fuel pumps, to which the tanks were directly connected. One tank was then used for test runs and the second for other movements. The amount of fuel expended for a given operation was obtained by weighing the particular tank on a solution balance, sensitive to one gram, just before and just after each test run.

Tests at the higher speeds were made on U. S. 45 north of Urbana, Ill. The road is portland cement concrete 18 ft wide, in good condition, with two curves of long radius having a combined central angle of about 50 deg. The profile is practically level except for two short grades of approximately 2 per cent. Runs at low speeds were made around a loop 1.4 miles long, consisting of parts of Race Street and Pennsylvania, Lincoln, and Florida avenues in Urbana. The pavements are of portland cement concrete in good condition, excepting Lincoln Avenue, which has a brick surface in equally good condition. The grades are light except for two short stretches of about 3 per cent. Test runs for each route were made in both directions on days when the pavements were dry, the temperature of the air above 40 F, and the winds light.

Arrangement of Apparatus in Car C

Driver Operated Tanks and Took Edometer Readings for Recorder in Back Seat

When calibrated over a measured course, the speedometer for Car B regis-

tered 9 per cent high at all speeds above 20 miles per hr, but the speedometers on the other cars were practically correct. Allowance for the error was made so that actual speeds were recorded. The odometer on Car B registered 6 per cent high, while the other odometers were practically correct. Corrections for odometer errors were made wherever needed in the calculations.

Each test run with stops was made in the following manner. The test tank was carefully weighed and put into place. The car was brought to the starting point using the service tank. The service tank valve was then closed, the test tank valve opened, and the car was accelerated in a normal manner to the desired speed. After the car had traveled at this speed a short distance, it was brought to a full stop and then immediately was accelerated to the same speed as before. After a short run it was again brought to a stop. This process was repeated until the desired number of stops had been made. The test tank was then shut off, the service tank opened, and the car turned around. The process was then repeated in the reverse direction to the starting point, where the tank was again weighed. The odometer reading and the time were recorded for each stop, together with the accelerating and decelerating distances and times. After a little practice it became possible to read the odometer, with its tenth of a mile graduations, to the nearest 0.01 mile. Time was recorded to the nearest second.

On account of traffic conditions the length of the run between stops varied somewhat, but in no case could it be so short that the brakes would be overheated. The stops were all made at a moderate rate and not to the full capacity of the brakes. In other words, they were normal and not emergency stops.

In most of the tests the stops were made by throwing out the clutch and applying the brakes at the same time. In this way the stop was made wholly by brake action. This method was chosen because it seemed to be the one least subject to variation and to be likely to give conservative results. For the sake of comparison, however, one set of runs with Car C was made at a speed of 40 miles per hr in conventional gear, using the engine as a retarding agent in addition to the wheel brakes to reduce the speed to about 10 miles per hr before the clutch was released. Another set of runs was made at 40 miles per hr with Car C, in which the stops were made by "free-wheeling" to about 30 miles per hr and then applying the brakes. One or two runs were made on each car at each speed, the number being determined by the distances of travel required to obtain at least 40 net stops for each test. A "stop run" was immediately followed by a "non-stop run" over exactly the same course and as nearly as possible at the same given speed.

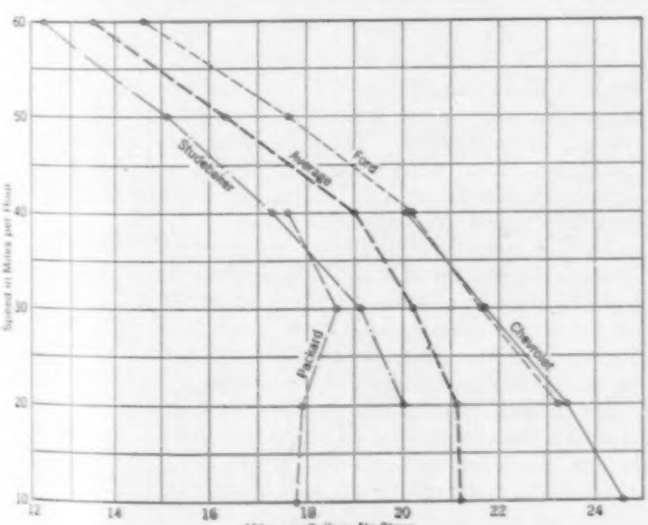


Fig. 1 Rise in Fuel Consumption with Increase in Speed

Results of Tests Interpreted

In order that the results of the tests may be conveniently interpreted, they have been shown graphically

A Test Car, with Apparatus
Tanks Controlled by Observer in Rear Seat

in Figs. 1, 2, 3, and 4. As indicated in Fig. 1, the fuel consumption rises, or the number of miles per gallon falls, with increased speed and at an increasing rate. This increase in fuel consumption at an increasing rate has a bearing on the cost of stops at higher speeds. In Fig. 2 is shown the total gasoline consumed while making a stop. Since the stop was measured between the points where deceleration commenced and acceleration to normal speed was completed, these values obviously include the fuel required to move the car over this distance. Although these data are therefore of limited value, they do serve as a check on the consistency of the results.

Plotted in Fig. 3 is the excess gasoline per stop, or the additional amount of fuel burned while making a stop over that used in traversing the total decelerating and

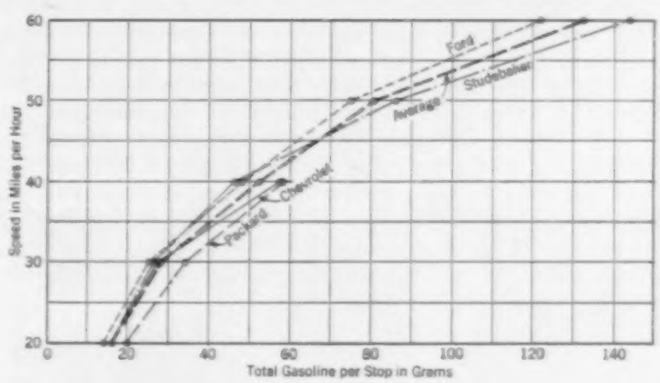


Fig. 2 Amount of Gasoline Consumed in Making a Stop

accelerating distances at the given uniform speed. These quantities are the measure of increased fuel costs due to stops. It is to be noted that they increase at a rather uniform rate with the speed up to about 50 miles per hr, beyond which the rate of increase falls off considerably. This is to be expected in view of the rapid rate of increase of fuel consumption at high speeds.

Finally, Fig. 4 shows the excess fuel consumed per stop reduced to equivalent miles of running at the uniform speed from which the stop is made. It is to be noted that the values obtained from the different cars at the same

speed lie in a relatively narrow band. The curve of average values therefore seems to be reasonably representative of the equivalent mileage of a stop for an average car. The same relation is true of Figs. 2 and 3.

WHAT IS THE COST PER STOP?

These data can now be utilized in arriving at the actual cost of a stop. In addition to increased gasoline con-

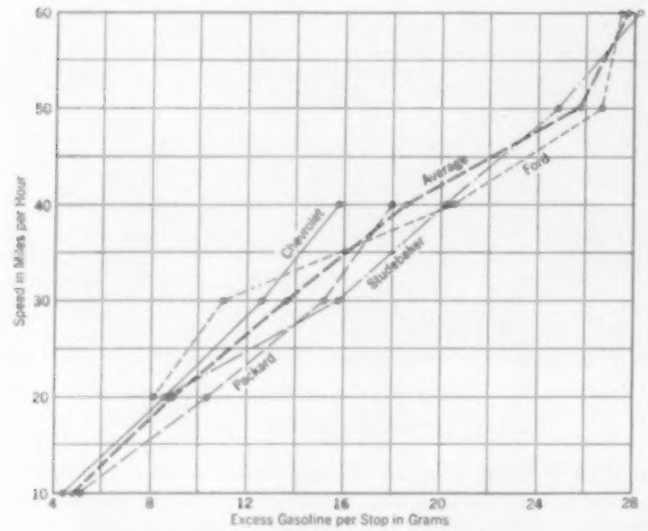


FIG. 3. EXCESS GASOLINE CONSUMED PER STOP

sumption, a stop adds to the cost for oil, tires and tubes, maintenance, and depreciation. Elaborate data have been collected by Thomas R. Agg, M. Am. Soc. C.E., which show that oil costs are about one-sixth of those for gasoline. There appears to be no reason why this ratio is not applicable to the cost of stopping as well as moving.

Evidently a considerable part of the wear on tires is due to stopping and starting. The wear over the accelerating and decelerating distances when a stop is made is undeniably much greater than that over the same distance at a uniform speed. It seems reasonable to assume that the increased wear on tires on account of a stop varies as the equivalent miles per stop for gasoline consumption, on the basis that tire wear and propulsive effort are directly related. Therefore, the tire costs in Table II were obtained by multiplying the equivalent mileage values for the respective speeds by 0.29 cent, the cost per mile of tires and tubes for an average car, as determined by Dean Agg and explained in his paper, "Estimating the Economic Value of Proposed Highway Expenditures," in TRANSACTIONS, Vol. 99 (1934), page 1129.

TABLE II. COST OF PASSENGER AUTOMOBILE STOPS IN CENTS

ITEM	SPEED, IN MILES PER HOUR					
	10	20	30	40	50	60
Gasoline (18 cents per gal)	0.031	0.058	0.088	0.119	0.164	0.189
Oil (1/6 cost of gas)	0.005	0.010	0.015	0.020	0.027	0.031
Tires	0.010	0.019	0.028	0.036	0.043	0.050
Maintenance	0.010	0.020	0.030	0.040	0.050	0.060
Total	0.056	0.107	0.161	0.215	0.284	0.330

Although no information is available concerning the amount of maintenance costs due to stops, it is certain that practically all the required maintenance of brakes and clutch can be attributed to stops. Experiments performed by makers of brake linings have shown that an average car makes a stop for each mile of running. This I have personally verified; my car made approximately 2,900 stops in 3,000 miles of travel of a general nature. By assuming that the brakes and clutch require $10 worth of attention, such as adjustment and relining, for every 20,000 miles of travel, an average stop costs 0.05 cent. Of course this value will vary with speed. To be conservative, a straight-line variation between no cost at zero miles per hour and 0.05 cent at 50 miles per hr was assumed for general maintenance in preparing Table II. Since depreciation due to stops is small, and necessarily indeterminable, it has been neglected.

It is worth noting that at 30 miles per hr the cost of tires per stop is almost exactly one-tenth of the total tire cost per mile—0.028 cent as compared with 0.290. With an average of one stop per mile, this means that stops cause one-tenth of all tire wear, which seems reasonable.

Although these costs are based on very limited data, they nevertheless indicate that the expense of starting and stopping an automobile at present-day speeds is

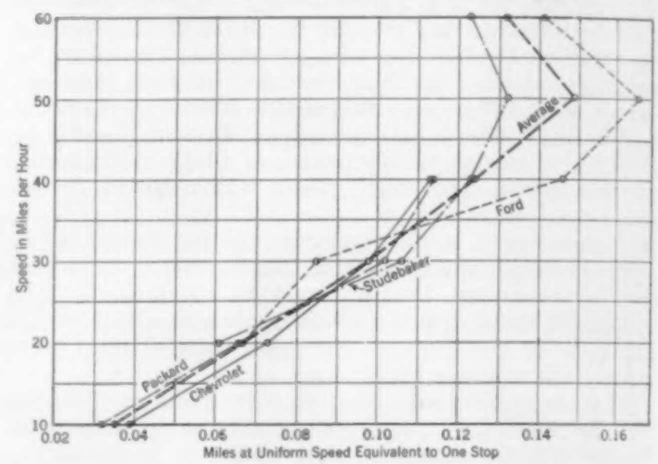


FIG. 4. EXCESS GASOLINE CONSUMED PER STOP REDUCED TO EQUIVALENT MILEAGE AT UNIFORM SPEED FROM WHICH STOP IS MADE

greater than has ordinarily been assumed and most certainly is not negligible. Costs due to time lost though traffic delays are intangible on the whole. This is not true of the cost of stops. A stop eliminated means less gasoline burned, less oil consumed, more tire mileage, fewer repairs to brake and clutch—all very tangible items in the cost of automobile operation.

EXTENDING THE STUDIES

Research to obtain more information on the cost of stops is highly desirable. The actual effects on oil consumption, tire wear, and maintenance should be adequately investigated. Tests to determine gasoline consumption on a more varied group of cars of modern design should be made. Also, the commercial vehicle certainly merits considerable study.

In the meantime, highway engineers should cease to neglect the matter of stops, which from these preliminary investigations are shown to cost at least 0.15 cent each at moderate speeds, and more than 0.25 cent each at higher speeds. Just as reduced operating costs have justified the construction of thousands upon thousands of miles of high-type pavement, so the savings to motorists through the elimination of stops will justify the design of better facilities for highway traffic and its regulation. Perhaps this investigation will stimulate the interest of engineers and others and thereby assist in developing a wider and better concept of the economics of automobile stops.

Centrifugal Method of Testing Models

Photo-Elastic Apparatus Combined with a Centrifuge to Secure Direct Measurement of Stresses

By Philip B. Bucky

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Results of a cooperative development of a new method for testing models to determine the behavior of structures under gravitational load is here reported. One of the difficulties in model experimentation has been to increase the effect of gravity in the model in the same proportion as the linear scale is decreased. When this is done, unit stresses are equal, and deflections and displacements at corresponding points in model and prototype are proportional and can be directly measured. In these studies the action of gravity on the prototype was simulated in the model by placing it in a centrifugal machine. Stresses in the isotropic transparent material of the model were taken from photo-elastic fringes made by the aid of a mercury arc stroboscope, which "stopped" the rotation at the instant of exposure. This interesting and valuable program of research is a joint effort of the Engineering Foundation, Columbia University, and the Committee on Soils and Foundations of the Society.

Realizing that many engineering problems cannot be solved mathematically, the engineer is coming to a fuller recognition of the importance and value of solutions obtained by means of models through the application of the principles of similitude. These are now the accepted methods for attacking many of the problems in hydraulics, aerodynamics, and ship design.

Of interest and promise at present to civil and mining engineers dealing with problems concerning the behavior of weighty structures—whether composed of solid, liquid, or loose materials—are the following subjects: (1) the behavior of scalar models of the same material as the prototype when subjected to centrifugal forces; (2) the behavior of loaded models of isotropic, transparent materials when investigated by photo-elastic methods; and (3) the subject of this article, the behavior of isotropic, transparent models when subjected to centrifugal forces and investigated by photo-elastic methods.

THE CENTRIFUGAL METHOD OF TESTING

By comparing the behavior of a structure with that of a small scale model, made in every part of the same materials as its prototype, a principle of similitude may be established by the laws of mechanics, as was done in the paper by Philip B. Bucky, "Use of Models for the Study of Mining Problems" (Technical Publication 425, American Institute of Mining and Metallurgical Engineers). The principle is that if in the model the pull of gravity on each part can be increased in the same proportion as the linear scale is decreased, then the unit stresses at similar points in the model and prototype will be the same, and the displacement or deflection of any point in the model will represent to scale the displacement of the corresponding point in the prototype. The effect of an increase in gravity may be obtained by substituting a centrifugal for the gravitational field, that is, placing the model in a suitable designed centrifugal machine, or centrifuge. While the radial centrifugal field is not uniform in either amount or direction, it may be assumed as approximately uniform if the radius of the centrifuge is large compared to the dimensions of the model.

Establishment of this principle makes possible the model study of the behavior of projects of large magnitude stressed within and beyond the elastic limit. The model may be wholly solid or not. The extension of this principle to hydrostatics, as in dams and problems involving liquid and gaseous flow, is of interest.

For studying the behavior of loose materials, such as sand, the basic requirement is that the size of the sand particles in the model shall bear the same ratio to that in the prototype as the model scale, each particle being in effect an individual model. Temperature effects may also be included in the model.

CENTRIFUGAL TESTING APPARATUS

In Fig. 1 the apparatus for studying the behavior of models in centrifugal fields is shown. It consists essentially of a case, A, in which is mounted a rotating box. The models are put in this box, shown in a photograph, so that observations of their behavior can be made through the openings. The case, A, also has an observation port where a camera, C, or a mirror may be placed. Speed is measured by the generator, D, which is geared to the shaft. The speed, which in this case is directly proportional to the generated voltage, is read at the voltmeter, E. Light for observation is obtained from

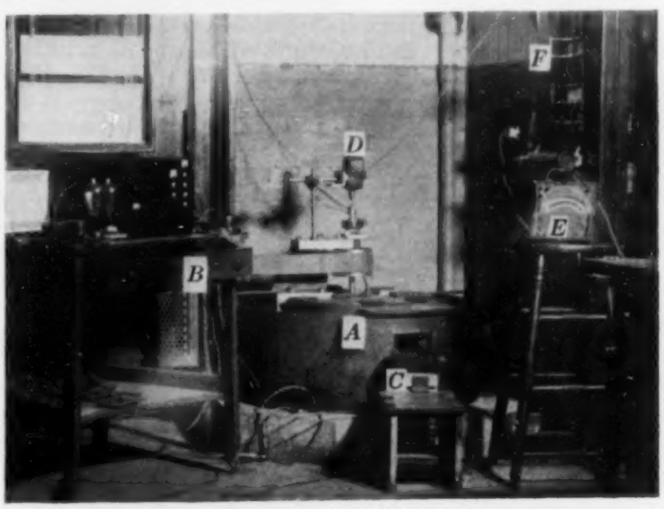


Fig. 1. Centrifugal Testing Apparatus

a stroboscopic mercury arc light, developed by H. E. Edgerton and described in his article, "Stroboscopic Moving Pictures," in *Electrical Engineering* for May 1931. The arc forms in a circular tube placed directly

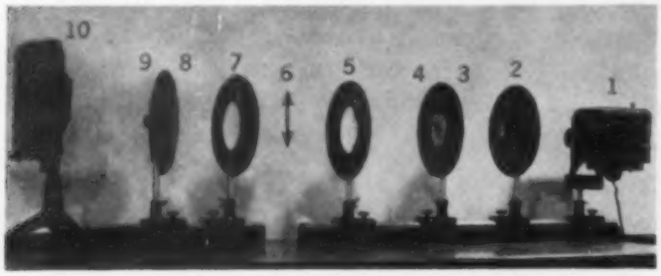


FIG. 2. PHOTO-ELASTIC APPARATUS IN POSITION

1. Point Source of Light
2. Condenser
3. Polarizer
4. Quarter-Wave Plate
5. Lens
6. Space for Stress Device
7. Lens
8. Quarter-Wave Plate
9. Analyzer
10. Screen

in front of the camera, *C*. The controls for this device are shown at *B*. The device makes a light of very short duration at the moment when the model comes to a selected position directly in front of the camera. It is of such intensity and quality that no difficulty is experienced in obtaining photographic records of the behavior of the model at any speed. At the present time moving picture records may be made of a complete test carried through to failure of the specimen. Photographic records of the behavior of a model of a uniformly loaded beam, both while rotating and after removal from the centrifuge, are shown.

It may now be pointed out that if a model of a beam be rotated at such a speed that the centrifugal force on each particle is equal to 100 times the gravitational force, it will behave like one whose similar linear dimensions are 100 times those of the model, under the action of gravity. For example, a model beam of 10-in. span, 1-in. depth, and 2-in. width will behave like a prototype whose dimensions are as follows: span, 1,000 in.; depth, 100 in.; and width, 200 in. If the model deflection as measured from the photographic plate is 0.01 in., then the deflection of the prototype at a similar point will be 1 in.

The behavior of the model while rotating may also be considered from the standpoint of loading. If the weight of the model material is 1 oz per in. of span, its load in the gravitational field is 1 oz per in. In a centrifugal field of force 100 times that of gravity, its load is 100 oz per in. Rotation in a centrifuge therefore has the additional advantage of furnishing a method of applying a uniform load of any desired degree to any member or combination of members.

EXPERIMENTAL USE OF PHOTO-ELASTIC METHOD AND APPARATUS

The photo-elastic method of stress measurement determines the stress distribution in a two-dimensional body by optical means. It makes use of the fact that when a piece of isotropic transparent material such as glass, celluloid, or bakelite, is stressed and viewed in polarized light, a picture is seen which indicates by its color bands of light, or fringes, the magnitude of the stresses and their distribution. The stress distribution in a bakelite beam in pure bending under static loading is shown in a photograph. Each fringe is a series of points of equal maximum shear stress and may be compared to a contour line. The value of the stress for each fringe may be obtained experimentally by testing a calibrating beam in pure flexure, the material of the beam being the same as that of the model. In the photograph the neutral axes can be noted. If the material is of such size that a fringe corresponds to a stress of 100 lb per sq in., then the first fringe below the neutral axis represents a series of points whose stress intensity is 100 lb per sq in. in tension; the first fringe above the neutral axis, a series of points of 100 lb per sq in. in compression; the second fringe, 200 lb per sq in.; and so on. When the

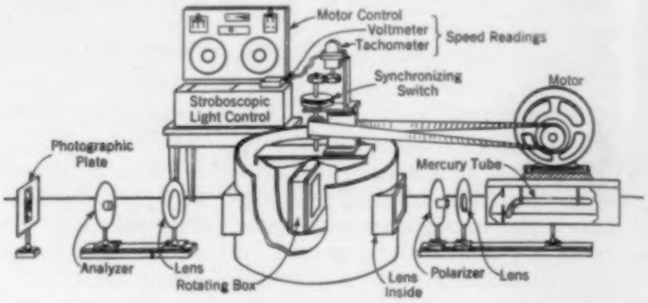
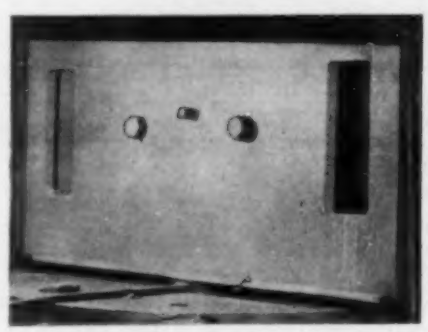


FIG. 3. DIAGRAMMATIC REPRESENTATION OF COMBINED CENTRIFUGAL AND PHOTO-ELASTIC EQUIPMENT

load is gradually applied, the outer fringe, both top and bottom, appears first and moves toward the neutral axis as the load is increased.

In Fig. 2 the photo-elastic apparatus is shown. Light from a point source, 1, passes through a condenser, 2, and reaches the polarizer, or first Nicol prism, 3. Here it is plane polarized, that is, the vibrations of the light rays on leaving the prism occur in one definite plane, which is normal to the direction of propagation of the light. It then passes through the lens, 5, and the unstressed model in the stress frame, to be placed at 6. The rays then pass through the lens 7, after which they converge and pass through the analyzer, or second nicol prism, 9, and may be viewed on the screen, 10. If the nicol prisms are crossed, that is, if the principal plane of the analyzer prism, 9, is set at 90 deg to that of the polarizer prism, 3, the beam will not pass the analyzer, so that by this means the light is completely extinguished. Any rotation of one prism will produce partial illumination. If the model is stressed, however, a ray of polarized light going through it will divide into two rays, having a relative retardation in proportion to the intensity of the shear at a given point, because of the double refractive powers of isotropic materials under stress.

If white light is used as a source, color will appear on the screen in successive groups of bands of yellow, red, and green, depending on the intensity of the stress. If one of the principal stresses at some point is parallel to the plane of polarization of the parallel beam of light, the ray through this point will not be decomposed, and a dark spot will appear on the screen. To avoid this, the plane polarized light is changed to circular polarized

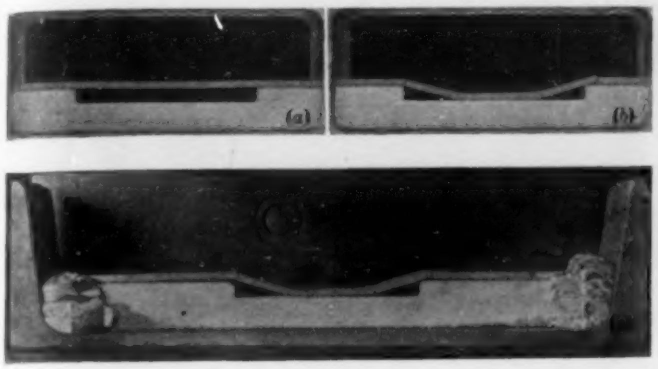


THE ROTATING BOX OF THE CENTRIFUGE
Observations on the Model Are Made Through the Openings

light by the introduction of two quarter-wave mica plates, 4 and 8, with their optical axes at 45 deg to those of the nicol prisms and at 90 deg to each other.

COMBINING CENTRIFUGAL AND PHOTO-ELASTIC EQUIPMENT

If a scalar model of the same material as the prototype is placed in a centrifugal field whose intensity compared to the gravitational field is equal to the linear dimension of the prototype divided by the corresponding model



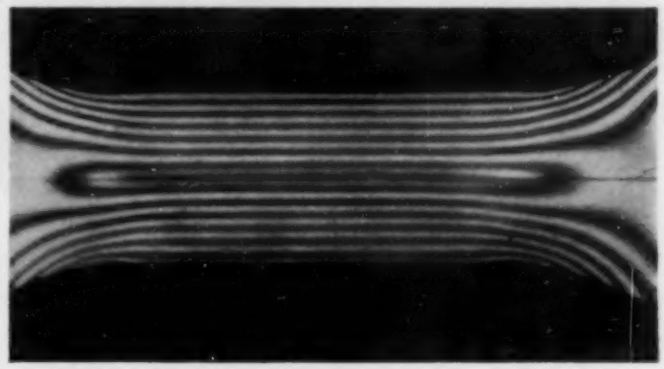
MODEL OF A UNIFORMLY LOADED BEAM DURING AND AFTER TEST
(a) Rotating at 600 rpm; (b) Failure at 715 rpm, While Rotating; (c) Failed Model Removed from Centrifuge

dimension, the model will have unit stresses equal to, and displacements at similar points proportional to, those in the prototype. Also, if this model is made of isotropic transparent material, by application of photo-elastic methods it will give the stress distribution, provided the material is stressed within the elastic limit. It therefore follows that if these two methods are combined, the stress distribution in certain structures stressed within the elastic limit may be obtained. It is also possible to take a simple structure, as for example a cantilever beam, load it by placing it in a centrifugal field, and check this theory.

To verify this theory the apparatus shown in Fig. 3 was built, differing only from the apparatus of Fig. 2 in the substitution of the centrifuge for the stress frame and in the substitution of stroboscopic light for the point-source light. Lens 5 is supported inside the box.

It is also possible to substitute for the stress frame such types of rotating objects as gears, fly-wheels, and pulleys, to apply the stroboscopic source of light, and to obtain photographs of stress distribution in these bodies while they are rotating.

Experimental verification of the accuracy of the combined methods was obtained by placing in the centrifuge a cantilever beam of bakelite, 0.294 in. wide, 1.130 in. deep, and 5.50 in. long. The beam in place in the cen-



STRESS DISTRIBUTION IN A BAKELITE BEAM IN PURE BENDING
Neutral Axis and Photo-Elastic Fringes Are Visible

trifuge may be seen in Fig. 4, and the resulting stress pattern is shown by the fringe when the beam was rotated at 2,000 rpm. The distance from the center of rotation to the center line of the beam was 7.06 in. The strength of the centrifugal field as compared to that of the gravitational, generally referred to as the model ratio, R, is given by the following formula:

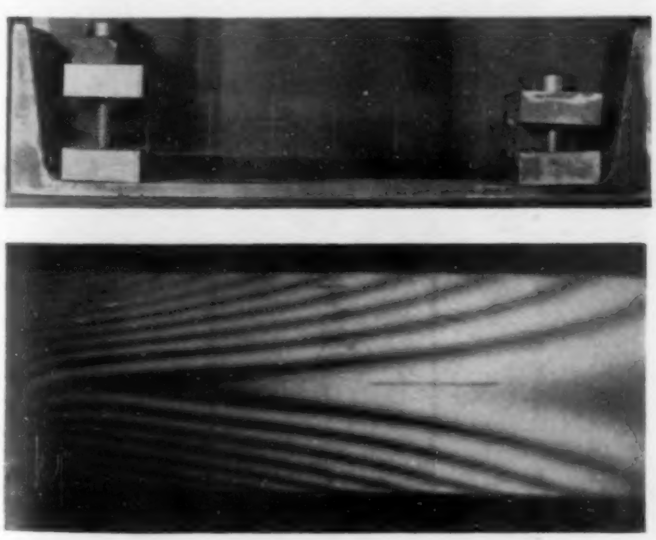
$$R = \frac{4\pi^2 r n^2}{g}$$

in which π equals 3.1416; g, 32.2 ft per sec per sec; r, radius of rotation in ft; and n, revolutions per second. For this case,

$$R = \frac{4\pi^2}{32.2} \times \frac{7.06}{12} \times \left(\frac{2{,}000}{60}\right)^2 = 801$$

The load per inch of beam in the gravitation field equals BDd, where B is the breadth; D, the depth; and d, the weight per unit volume for bakelite. This load is equal to 0.01531 lb per in. of beam. The load per inch of beam in the centrifugal field then equals 801 times 0.01531 lb, or 12.2 lb.

The theoretical stresses at the extreme fibers were



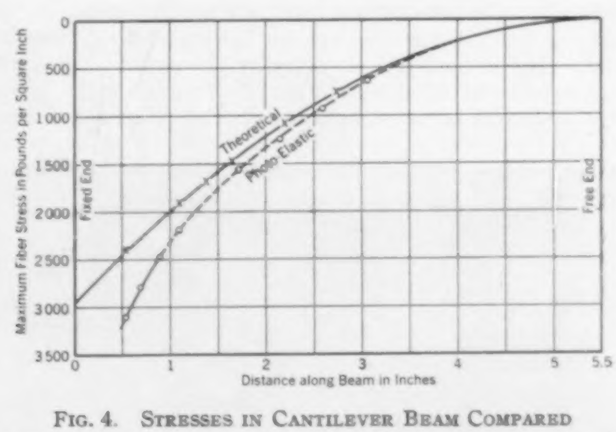


FIG. 4. STRESSES IN CANTILEVER BEAM COMPARED
Upper Left: Cantilever Beam in Centrifuge Holder, with Vertical Lines on Beam 1 In. Apart. Lower Left: Part of Fringe Stress Pattern Caused by Rotating Beam at 2,000 rpm. Above: Stresses by Model Method Compared with Those Found Analytically

calculated and are plotted in Fig. 4. In the same diagram the stresses at the extreme fibers taken from the fringe pattern are shown. The general agreement may be noted.

The other point of interest is that this bakelite beam gives the stresses and their distribution in a prototype of the same material, each of whose dimensions is 801 times that of the model. The dimensions of the prototype for this case are as follows:

$$\text{Width} = \frac{0.294 \times 801}{12} = 19.6 \text{ ft; depth} = \frac{1.13 \times 801}{12}$$

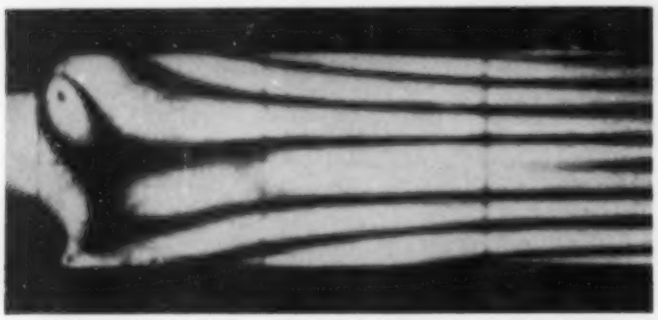
$$= 75.5 \text{ ft; and length} = \frac{5.5 \times 801}{12} = 357 \text{ ft.}$$

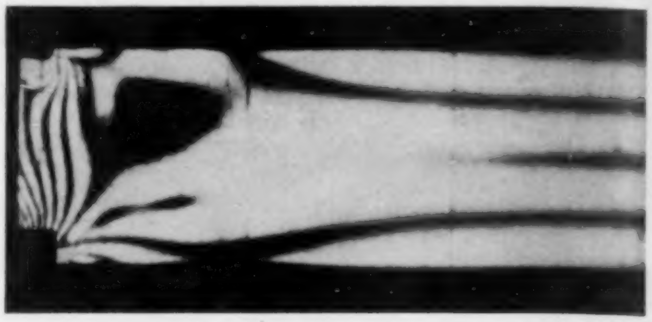
If this model were rotated until failure occurred the dimensions of a prototype in which similar failure would occur would be available. While the civil engineer is not necessarily interested in designing structures that fail, the mining engineer is so interested because under certain conditions it is an economical method of breaking ore.

Additional studies of the behavior of isotropic transparent beams under centrifugal stress have been undertaken to obtain further evidence of the agreement between the experimental results as obtained by the centrifugal photo-elastic method and those computed from standard formulas. Typical stress fringe patterns of simply supported and fixed-end types of beams are illustrated. A comparison of the maximum fiber stresses in the middle of these beams shows satisfactory agreement.

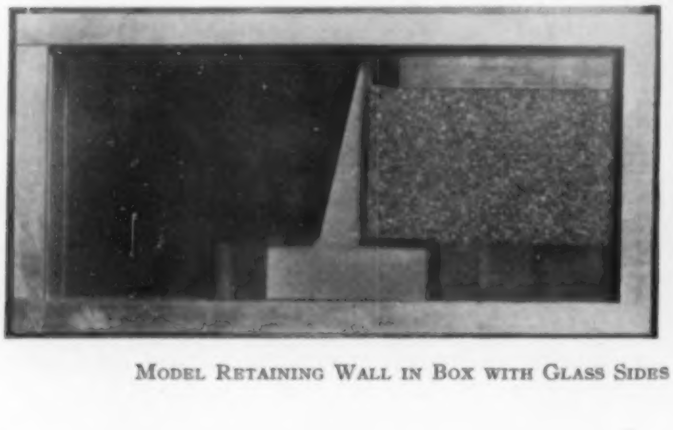
As a matter of interest, a model of a retaining wall whose load is due to sand and a surcharge of steel is pictured. The model is shown in a metal box with glass sides to permit the passage of light and to retain the sand. If the material is correctly chosen and sized and then rotated at a calculated speed to simulate the prototype, the unit pressures on the model will be the same and will occur at points similar to those in the prototype. This model was run at a speed of 1,500 rpm, equivalent to a model ratio of 485; that is, the centrifugal field had a strength 485 times the gravitational one. A photograph of the fringe stress pattern of this retaining wall, which includes the effects of the glass wall, is also shown.

A combination of the centrifugal and photo-elastic apparatus makes available a tool of value from the standpoints of design and investigation. Use of this combined method enlarges the number of problems that lend themselves to solution by model study, especially as regards the behavior of weighty structures of either solid or loose materials or their combinations.

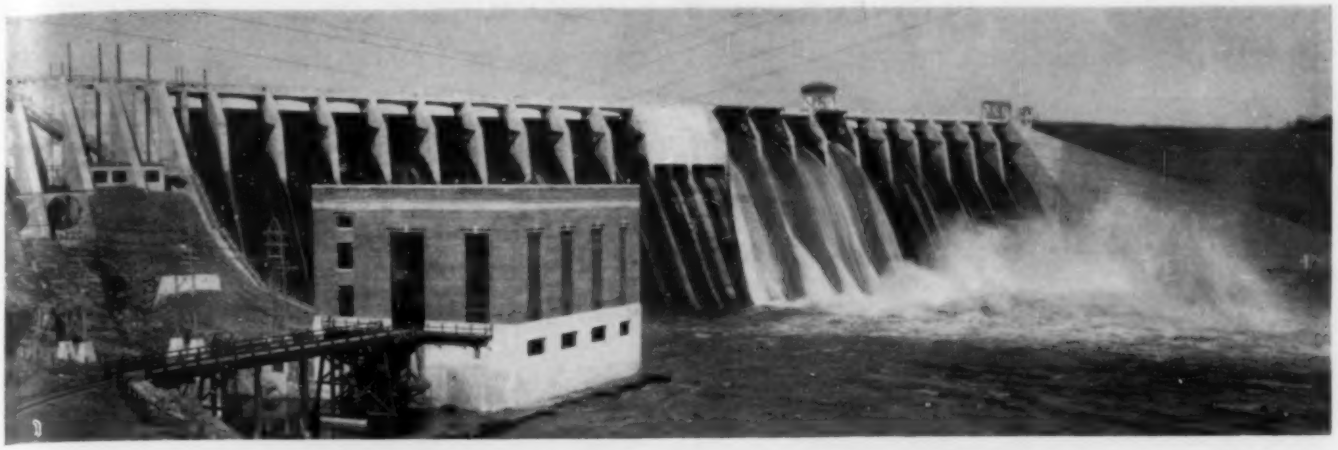




TYPICAL FRINGE STRESS PATTERNS: AT LEFT, FOR A SIMPLE BEAM, AND AT RIGHT, FOR A RESTRAINED BEAM



MODEL RETAINING WALL IN BOX WITH GLASS SIDES AND A FRINGE STRESS PATTERN OF THE MODEL WALL



BARTLETT'S FERRY DAM, CHATTAHOOCHEE RIVER, GEORGIA AND ALABAMA
A Combined Power and Reservoir Project That Would Be Materially Aided by Additional Storage Upstream

Valuation of Upstream Storage Reservoirs

Engineering Principles Illustrated by Various Methods of Estimating

By EDGAR E. FOSTER
ASSISTANT ENGINEER, U. S. ENGINEER OFFICE, MOBILE, ALA.

WHENEVER a storage reservoir is built on the upper reaches of a stream used for hydro-electric power, it benefits every plant at or below the site. Just how much this benefit may be in terms of dollars and cents is a nice problem, to which Mr. Foster addresses himself. By means of examples he develops the basic principles involved. He shows that headwater improvements can be valued by comparison with a steam plant having a capacity equal to the increase in prime power contributed by the reservoir. Another basis for apportioning the value of the upstream improvement among several plants is in terms of prime power. This includes that at the reservoir itself and the increases obtainable from added prime flow at the plants downstream. Such computations show that the benefits obtainable from headwater improvements may cost more than their value as measured in terms of the cost of providing equivalent steam capacity. This paper is replete with a most practical sort of information for use by engineers.

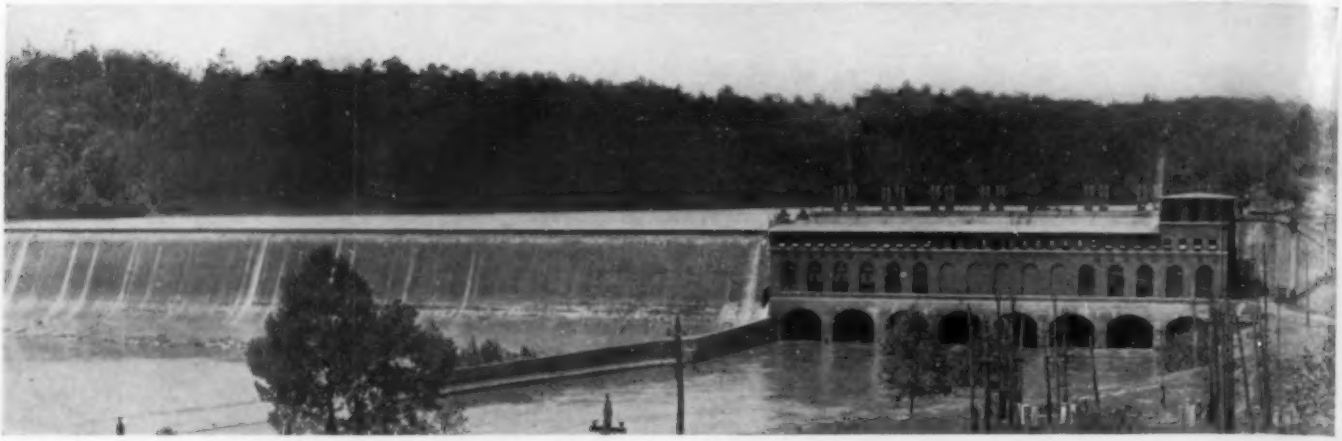
IN developing a river for hydro-electric power, a peculiar problem of valuation arises whenever storage reservoirs are constructed on the headwaters to regulate flow, thus benefiting a number of power plants on the lower reaches of the stream. As the number of hydro-electric projects becomes greater, a solution for this problem becomes increasingly urgent. Moreover, the Federal Water Power Act accentuates the problem by requiring that some solution be found for the purpose of allocating the annual expense of headwater improvements among the beneficiaries. A just and equitable division of cost must be sought in a fair valuation based on sound economic principles.

This necessity for evaluating the benefits of storage is acute only in case different parties own the reservoir and the power plants. Nevertheless, it is always desirable to estimate the benefits even when the same party owns both. When the owner of the hydro-electric plant is a licensee of the Federal Power Commission, he is required to reimburse any other licensee who may have built a storage reservoir upstream. The problem then is to find a basis on which to evaluate the increased flow.

Primarily the value of any storage reservoir is due to its function of increasing the stream flow during periods of deficiency. No stream has a constant flow through the year, and the discharge of most rivers used for power purposes varies greatly from the flood to the dry season. Storage reservoirs are designed to correct this seasonal variation as far as possible. Although the reduction of flood stages downstream may be beneficial, such benefit, except in special cases, is small and its value is negligible at any considerable distance below the reservoir. On the other hand, the benefit from increasing the low flow is of decided importance and may be felt far below the reservoir. Now stream flow may be considered as the raw material of a hydro-electric plant. A storage reservoir therefore directly increases the raw material and the resulting production of all power plants below at the time of greatest need. In this article the value of storage will be considered only with respect to hydro-electric power.

A FEW TERMS DEFINED

First, it is necessary to make some analyses of stream flow and storage and to fix some basis of value for hydro-electric energy as compared with energy derived from other sources. For computing hydro-electric power, stream flow is conveniently divided into two classes, prime and secondary. Prime flow is that which for all practical purposes may be considered as available at all times. Engineers take somewhat different quantities as prime flow, since the minimum recorded discharge is usually lower than that which constitutes a dependable supply. It may be taken as the usable flow over 95 or 98 per cent of the time; it may be taken, as it is here, as the minimum mean monthly flow. The secondary flow is the rate of flow available in greater magnitude than prime flow, up to the capacity of the turbines. Secondary flow is consequently available for only a part of the average year.



A RUN-OF-THE-RIVER PLANT AT MORGAN FALLS, ON THE CHATTAHOOCHEE RIVER
With No Storage and Little Pondage

There are likewise two classes of power: prime, or firm as it is also called, and secondary. Each of these two classes of power is named from the type of stream flow from which it is developed. In *Power Supply Economics*, Justin and Mervine define the prime, or firm, capacity of a hydro-electric plant as "that portion of its total installed capacity which can perform the same function on the portion of the load curve assigned to it as an alternative steam capacity could perform." This is a complete definition and will so be considered here.

Furthermore, reservoir capacity may also be conveniently divided into two classes, pondage and storage. Pondage is the small reservoir capacity which is sufficient to hold the total 24-hr inflow for use when it is needed to carry the daily load and which also may store the unused part of the inflow during Sunday for use later in the week. Pondage is necessarily located at the power plant. Storage proper is all capacity in excess of pondage and may be at the power plant or in a reservoir far upstream on the headwaters. In order to be of any benefit, storage capacity must be sufficiently great to save water during periods of heavy run-off and release it when needed during periods of deficiency.

VALUING HYDRO-ELECTRIC POWER

Prime power, since it is always available, is of course the more valuable kind. In this respect prime hydro-electric power is on an equal footing with steam power and has the same value as has energy from steam generation. Steam power is the principal source of energy and is essentially an unlimited producer since it can be provided virtually wherever it is needed. Hence steam power fixes the value of all energy when various sources are in competition. Thus the total unit cost of energy from steam generation becomes the maximum limiting value of energy from hydro-electric generation for the same class of demand, that is, when the two classes of power are interchangeable in the load curve.

Since secondary power is available only intermittently, other sources, usually steam, must be developed to carry the load during periods of low flow. Stand-by plants must therefore be constructed or other sources of energy must be made available for use during such periods. Ordinarily the investment in stand-by plants has already been made, and the fixed costs of such plants must be paid whether they are operated or not. Hence the only saving secured by utilizing secondary power in the usual load curve is the cost of fuel and incidental supplies. The cost of fuel per kilowatt-hour therefore becomes the maximum limiting value of secondary energy.

In evaluating the benefits of headwater improvements, evidently only a few factors can be accurately measured. There will be more or less variation in all elements due to differences in individual judgment. Nevertheless, all factors should be determined within limits as narrow as possible. This principle is so important that the worth of any method of valuation should be gaged, at least in part, by the exactness with which its elements can be fixed or measured.

These benefits may be measured by the additional prime, or firm, power made available at a downstream hydro-electric plant. Since a storage reservoir on the headwaters will increase the low-water flow, there will be a corresponding increase in prime power. Now assuming that prime hydro-electric power will fill all the functions of steam capacity, this additional prime power will have the same value as the cost of building equivalent

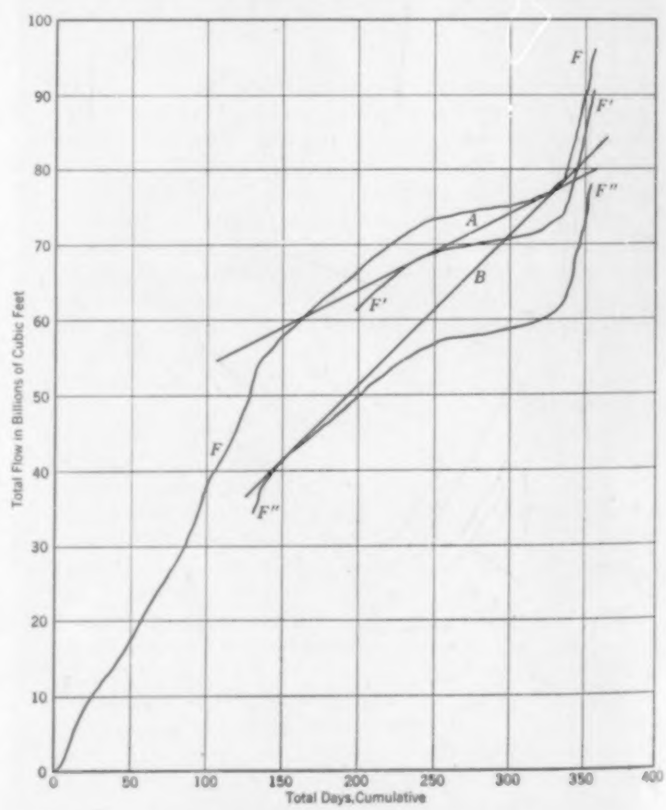
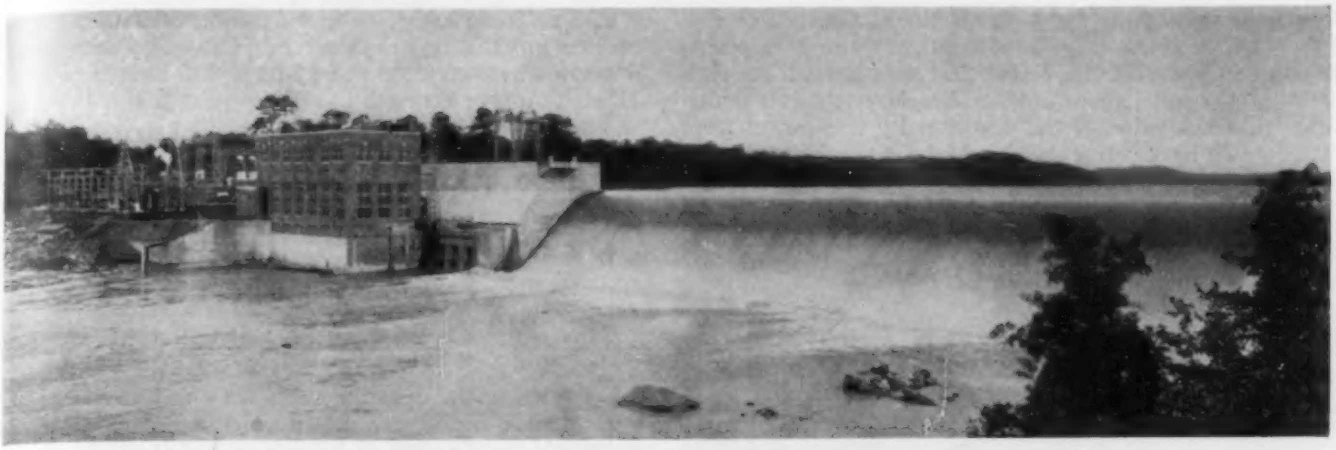


FIG. 1. FLOW-SUMMATION CURVE FOR USE IN COMPUTING PRIME FLOW



UPPER TALLASSEE DAM, TALLAPOOSA RIVER
Run-of-the-River Plant Utilizing the Storage of the Large Reservoir at Martin Dam

steam generating facilities at or near the center of the system's load. However, the additional prime power thus made available will probably be only a few thousand, or perhaps only a few hundred kilowatts. Steam plants for public utility purposes are usually of large capacity because this is necessary for highest efficiency and lowest unit cost. It seems proper that the valuation of the additional prime power obtainable from storage should be based on the analogous costs of steam plants which are sufficiently large to operate efficiently.

METHOD OF COMPUTATION ILLUSTRATED

To illustrate—a hydro-electric plant, here designated Project A, was completed under a license from the Federal Power Commission. The normal head with the pool full was 120 ft; the storage capacity, 5.2 billion cu ft; and the regulated prime flow, 1,400 cu ft pr sec based on the dry year of 1931. A few years after its completion another party applied for a preliminary permit to build Project B at one of several possible sites upstream, the most acceptable of which provided, with reservoir full, a head of 70 ft and a net storage capacity of 16.0 billion cu ft. The storage reservoir at Project B would evidently be of considerable value to Project A; that was especially true since the stream was rather flashy and its flow was low during the dry season.

GOAT ROCK DAM, CHATTAHOOCHEE RIVER, GEORGIA AND ALABAMA
A Run-of-the-River Plant with a Head of 80 Ft

Referring to Fig. 1, the regulated flow at Projects A and B may easily be computed from the flow-summation curve, F, the data for which were obtained from a gaging station between the two projects. The ratio between the drainage area above Project B and that above the gaging station is 0.97. The ratio between the drainage area above Project A and that above the gaging station is 1.20. In Fig. 1, F is the flow-summation curve of the discharge at the gaging station. The data were obtained for the driest period of record. The same curve, F, is plotted parallel to itself at a distance of 5.2/1.20, or 4.33 billion cu ft below to form curve F'. The common tangent, A, covering the period of smallest slope, represents the maximum uniform flow obtainable from the reservoir, considered at the gaging station. In the graph, the slope of A is 2.02/200, equivalent to 1,170 cu ft per sec. Multiplying this by 1.20 to allow for the difference in drainage area and to give the flow at the site of the project, the flow at Project A is found to be 1,400 cu ft per sec. Likewise, the same curve, F, is again plotted parallel to itself at a distance of 16.0/0.97, or 16.3 billion cu ft below, to constitute curve F''. Tangent B has a slope of 3.97/200, representing 2,300 cu ft per sec. Multiplying by 0.97 gives a flow of 2,230 cu ft per sec at the dam site.

Now after the construction of Project B, the prime inflow at Project A would consist of the regulated outflow from Project B plus the natural low-water run-off from the drainage area between the two projects. This natural run-off may be taken as 70 cu ft per sec. Then the total prime inflow at Project A as a result of the reservoir at Project B is 2,230 plus 70, or 2,300 cu ft per sec. The increased prime flow obtained from Project B is therefore $2,300 - 1,400 = 900$ cu ft per sec.

The power made available at Project A by this increased prime flow is the benefit obtained from Project B. The power should be based not on the normal head with reservoir full but on the head of the average drawdown—in this case, 108 ft—as typical of the dry period. The power obtainable is then

$$108 \times 900 \times 0.08 \times 0.746 = 5.800 \text{ kw}$$

based on an over-all efficiency of 70 per cent. Multiplying this by the unit cost of steam generation, estimated at \$85 per kw, the total value of the benefit created by Project B is 5,800 times \$85, or \$493,000.

Power is the product of two factors, head and stream flow, which may be considered as the two raw materials in the production of energy. They are equally important; neither can be utilized without the other. The head is inherent in the site of the hydro-electric plant generating the energy and is a feature that is paid for when the site is purchased. The benefits arising from

the head should therefore accrue to the plant that uses it. Now in evaluating the benefits of storage to plants below the reservoir, it is found that the reservoir supplies only additional stream flow. Therefore it seems equitable that the value of the additional prime power from headwater improvements should be shared equally by the reservoir and the lower plant.

In the example given, the total benefit is valued at

LANGDALE DAM, CHATTAHOOCHEE RIVER
Small Run-of-the-River Plant That Could Be Much Benefited by Proposed Headwater Improvements

$493,000. Dividing this equally, $246,500 accrues to Plant A because of ownership of the head and $246,500 is payable to Plant B for the value of the stream flow.

OTHER MEANS OF VALUATION

Yet valuation of headwater improvements is not a matter to be disposed of from a single point of view. In the last analysis, the value of any good is a matter of adjustment between the demand and the supply, which in turn is dependent on the cost of production. This adjustment of supply and demand is possible only in a free and extensive market. But such a market is not possible in evaluating the benefits of headwater improvements, and resort must be had to an imputed value. In order to make an accurate estimate for the imputed value, the problem should be considered from as many sides as practicable, and no relevant circumstances or information should be ignored.

Another line of investigation is opened up by considering that the benefits obtained from the headwater improvements consist in the conversion of secondary energy into prime energy. From any run-of-the-river plant a certain amount of prime power is available through the average year. For a shorter period of varying length, an amount of secondary power is obtained by generating from the secondary flow up to the capacity of the turbines. Both this prime and secondary power will be obtainable without storage. Depending on the rate of flow released from the reservoir in dry periods, the plant will convert a certain amount of secondary power into prime power by making the one-time secondary power available throughout the year. The added worth will be a function of both the increased value and the additional energy.

An inherent defect of this means of valuation arises from the difficulty of fixing the percentage of the time through which the conversion of a certain type of energy can be effective. The defect, however, may be eliminated by making the conservative assumption that the conversion applies throughout the average year.

To compute the value of storage on this second basis, in a recent study of the region in question, prime energy was appraised at 5.45 mills per kwhr and secondary energy at 2.35 mills per kwhr. The difference, 3.10 mills, is the increase in value due to converting secondary into prime power. The converted energy from 900 cu ft per sec of released storage through the entire year will amount to

$$900 \times 108 \times 0.08 \times 0.746 \times 8{,}760 = 50{,}800{,}000 \text{ kwhr}$$

At the given unit prices, its value is

$$0.0031 \times 50{,}800{,}000 = \$157{,}480$$

Dividing this sum between the two plants, the storage is worth $78,740 annually to Plant A. Capitalizing this sum of $78,740 at 6 per cent, it appears that this method considerably overvalues the storage.

STILL A THIRD BASIS

Considering the question from yet another viewpoint, the value of headwater improvements might be determined by the amount of water released from the reser-

MARTIN DAM ON THE TALLAPOOSA RIVER, ALABAMA
A Large Combined Reservoir and Power Project, with a Head of 145 Ft, Which Almost Completely Regulates the Stream Flow

voir. The capacity of the reservoir is known within narrow limits, and the outflow can be measured and the time of discharge determined with reasonable accuracy. If a valuation could be based on the amount of water delivered, it could be established with all desired exactness in so far as the physical elements are concerned. Yet, though the amount of water delivered to the lower plant is known, its value is not known, for that depends on its utility to the plant as well as on the cost of production.

In case a storage reservoir is owned jointly by several run-of-the-river power plants, the amount of water released can be advantageously used as a basis for allocating the cost of constructing and operating the reservoir. In this case it is not essential that the real worth of the storage capacity be evaluated. As joint owners, the run-of-the-river plants are required only to share equitably the cost of construction and operation, and each may then enjoy whatever benefit is obtainable by it according to its location. The quantity of water released therefore serves only as a means of allocating the cost of production and not as a means of evaluating benefits.

REQUIREMENTS OF THE FEDERAL WATER POWER ACT

According to the Federal Water Power Act, any licensee receiving benefits from headwater improvements constructed by another licensee must reimburse the latter for a proportionate share of certain annual costs, namely interest, maintenance, and depreciation for the improvement. The basis of the division and the methods of allocating the proportion of these expenses are left to the judgment of the commission. The problem

is therefore to find a basis for a just apportionment of these three items of expense.

This basis ought to consist of elements which may be determined with ease and reasonable accuracy and which are common to both the headwater improvement and the plant receiving the benefits of the storage, for only by means of such common elements can a uniform division be secured between the headwater improvement and the beneficiary in proportion to the benefits received by each. Obviously the only common element shared is the flow of water, and therefore the basis of the apportionment must be sought in the amount of water released from storage or in its products, power or energy.

BEST BASIS OF APPORTIONMENT

On first reflection, the amount of water released might appear to be the best choice, but there is a serious objection. Dams built for power generation perform two functions: they store water and they create the head necessary to produce power. The function of creating head is of benefit exclusively to one power plant while that of storing water benefits all plants, both at and below the reservoir. A part of the expense to be allocated is entailed by the construction of the dam as a creator of head, and that part should be carried wholly by the power output of the reservoir project. Only that part of the cost of the dam which pertains to it as a storage project is to be apportioned between the reservoir project on the headwaters and the beneficiaries downstream. But there is no clear-cut and definite basis on which this expense can be divided. The same problem necessarily arises in connection with the amount of water released from storage, since the benefits resulting from the capital investment are not in direct proportion to the amount of water released. The use of such water thus involves the difficulty of determining what part of the value of the dam and lands should be charged to the function of head and what part to the function of storage. For that reason this factor cannot form a uniform basis for allocating costs.

Mitchell Dam on the Coosa River
Large Run-of-the-River Plant with Week-End Pondage

Of the other elements, the amount of energy converted from secondary power to prime power is open to the same objections. There remains therefore as the basis for the desired apportionment only the amount of prime power produced at each plant by the new development. This total prime power will be here considered as the sum of that available at the upper plant plus the increase obtainable at the downstream plant due to the increased prime flow. Then the annual expense to be allocated will be borne by both plants. The downstream plant will pay in the ratio of one-half of the increased prime power to the total prime power, as previously defined, and the remainder of the expense will be borne by the upstream reservoir project. Head is an inherent feature of the site, and flow only is affected by the headwater improvement, so that it is equitable that the expense should be apportioned by using only one-half of the additional prime power at the lower plant.

A Small Plant That May Be Benefited by Upstream Storage
At the Albany Dam on the Flint River

In the example previously used, the cost of the reservoir was estimated to be \$6,132,000, for which interest at 7 per cent is \$429,240, the maintenance is \$10,000, and depreciation is \$4,000 per annum. The total annual expense is then \$443,240. The total prime flow at Project B is 2,230 cu ft per sec, and the head is 57 ft with the reservoir half full. Hence the prime power is 7,580 kw. The additional prime power made available at Project A was found to be 5,800 kw. Then the sum by which Project A should reimburse Project B for headwater improvement is

$$\frac{5{,}800}{2(7{,}580 + 5{,}800)} \times \$443{,}240 = \$96{,}068$$

The remainder of the expense, \$357,172, accrues to the reservoir project.

This \$96,068 appears to be too high. Estimating the fixed charges for a steam capacity of 5,800 kw at \$10.20 per annum per kw, the total annual fixed expense for steam is \$59,160. Thus the part of the annual expense for reimbursement of Project B exceeds the annual fixed charges of the equivalent steam capacity, which it should not do. In addition to illustrating the principle previously explained, this example directs attention to the contingency that headwater benefits may cost more than they are worth.

It remains only to emphasize the fact that hydroelectric development is expensive. This statement is equally applicable to headwater improvements. The advantages of such enterprises must be weighed carefully in order to estimate the value of the benefits that may result.

Perhaps it is unnecessary to add that each problem of valuation is the product of particular circumstances and therefore should be treated on its individual merits. At the same time economic principles have universal application just as do the physical laws of nature. It is in their application that particular circumstances must be considered.

Grouting Contraction Joints in Hogan Dam

Record of Operations Throws Much Light on Behavior of Arch Structures

By S. A. Thomas, Jr.

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Shrinkage in concrete arch dams has the effect of separating the blocks and thus effectively destroying the essential arch action. Water pressure would restore the necessary contact but in so doing would deform the arch. Grouting the joints, therefore, accomplishes several purposes. It replaces the volume lost in shrinkage, establishes the necessary interaction between adjacent parts, and permits adjustment of the position of the arch by proper control of grouting sequence and pressures. How these factors were correlated for the Hogan Dam, an arched flood-control structure in California, is here told by Mr. Thomas. Procedures were planned with care from the outset, although the grouting itself was delayed for a year and a half after construction, by which time the total arch joints aggregated a width of 1.2 in. By increasing the joint dimensions during grouting to almost 2 in., the arch was forced outward to its true position. The detailing of the careful procedure in this work, the valuable data presented as to quantities and methods adopted, and particularly the useful comments and practical suggestions for possible improvements in similar contingencies, combine to make this paper unusually interesting.

Flood control is the purpose of the Hogan Dam built on the Calaveras River in Calaveras County, California, by the City of Stockton in 1929–1930. Its concrete arch is of the constant-angle type, having a downstream overhang in the central part and an upstream overhang at the massive concrete abutments (Fig. 1). The entire left abutment is subject to water load, but three of the four blocks of the right abutment are relieved of such load by a gravity wing wall, on the right end of which is a gravel fill with a clay core.

Pertinent dimensions of the arch are given in Table I. The sections in Fig. 1 show Joints 11 and 4 of the arch, which were made vertical on certain radii, and Joints 2 and 22 of the abutments, which were warped and battered to a shape approximately normal to the direction of the thrusts at all levels. The keys of the arch joints were started vertical, but it was found that cracks due to long exposure of the surfaces were following the reentrant angles, and to prevent these cracks from extending to the upstream face, the keys were changed in direction as shown. The keys of the left abutment, as seen in Joint 22, were arranged to provide proportionate vertical and horizontal shear value, whereas those of the right abutment, Joint 2, were horizontal, since this abutment is not subject to water load.

Table I. Dimensions of Hogan Dam, in Feet

Item	Length	Height	Width	
			Crest	Base
Arch	620	115	15	50
Right Abutment	170	95	28	65
Left Abutment	130	75	7	73

As grout ducts for the joints, 2-in. half-round metal grout pipe was used, one half being placed on the forms and the other half being sealed to the first half when the forms were removed. For the arch joints generally, three horizontal feeders with vertical laterals were provided at different levels, as indicated for Joint 11 in Fig. 1, although for the abutment joints the system was much more extended. As in Joint 2, the first set was always placed as near the rock at the bottom of the joint as possible, and the inlet pipes were set as close to the ground surface as convenient.

General View of Hogan Dam from Left Abutment
Erection Equipment Still in Place

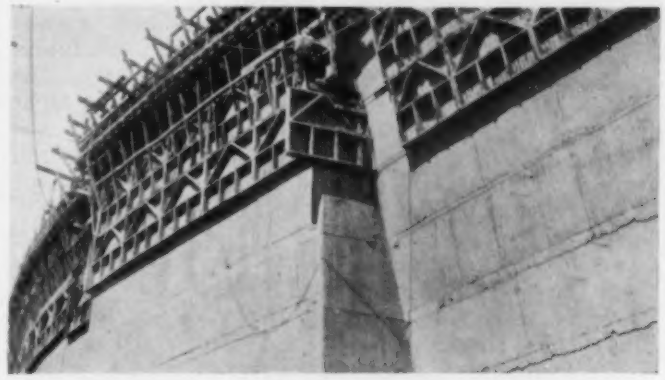
To place the concrete, the chuting method, which has since been largely abandoned, was used. Proper strength and workability with a cement content of 0.93 bbl per cu yd of concrete were secured under the most competent super-

vision, resulting in the minimum shrinkage obtainable under the conditions.

As a result of observation of other dams, the shrinkage problem was looked upon with considerable gravity. It was realized that it would be false economy to fail to provide adequately for shrinkage at the outset. The spacing of joints, which originally was 80 ft, was reduced where possible to less than 40 ft. A special inspector examined in detail all features of the joints and grouting system during construction. The joints were grouted one and one-half years after the completion of the dam, and no expense was spared in obtaining the desired results.

Preparations During Construction for Grouting

Before a new lift was placed, the connections of the copper water seals, grout stops, and grout pipes were inspected, and all parts of the pipe system were sealed with cement paste to exclude mortar. The surfaces of the concrete were cleaned, and some joints were painted with a special asphalt as a trial, but this precaution did not yield any noticeable advantage. On completion of each lift, the covered part of the grouting system was flushed with water. As the sections in Fig. 1 show, three or four separate sets of group pipe were installed for each joint. This procedure is necessary in order to localize the possibility of stoppage of the system and to provide access of grout at different levels. The result of such special precautions and careful arrangement was that every unit of the grouting system was open and in perfect order when the dam was finished.



Joint 20, Where Arch Meets Left Abutment
Overhang of Arch Itself Shown on Right

In general, all phases and provisions of the grouting

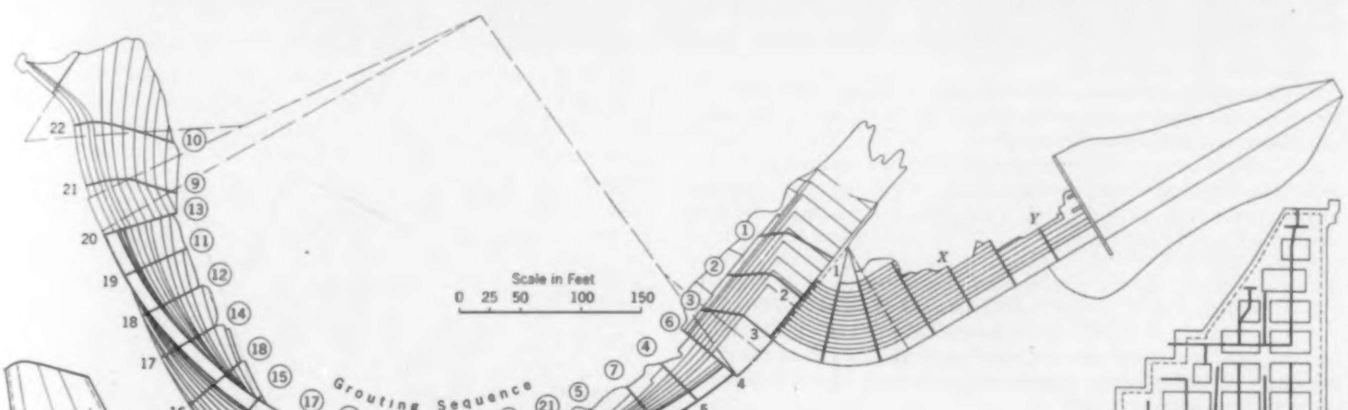


Fig. 1. Plan and Typical Joints of Hogan Arch Dam

program were satisfactory except as follows: (1) Riveting the joints of the grout stops resulted in some leakage, which required calking with lead wool and caused loss of time and added expense. (2) In the central part of the dam, where the joints were very tight near the crest, the proper introduction of grout was difficult. Higher pressures for grouting should have been available. These two errors are noted with the hope that they may be avoided in similar cases.

GROUTING—ORDER AND METHODS

On the general plan, Fig. 1, the order in which the joints were grouted is designated by circled numbers. This sequence was selected for the following reasons.

The abutments should first be prepared to take load. Starting with them, it is logical that support should be provided progressively toward the center. By using moderate pressures, alternate joints could be filled in advance, slightly opened, and prepared to transmit thrust. Following this the remaining "key" joints could be grouted under higher pressure. In grouting, the following procedure was adopted:

1. Each joint was filled with water and pressure was applied.
2. Leaks were calked with lead wool, but no attempt was made to hold a joint open while it was being calked, as the concrete would spall from the pressure on the calking when the water pressure was relieved and the joint closed.
3. All units of the grout system were tested by letting water out through each inlet pipe.
4. Water was withdrawn from the joints, and by attaching the air line to an upper inlet, most of the water at the bottom joint was blown out of the lowest inlet.
5. The grout machine on top of the dam was charged and the feed hose attached to the lowest inlet. When the joint opening was very small, or when the inlet had taken water slowly, the first batch tried was in the amount of 12 to 15 gal of water to 1 cu ft of cement. The mix was thickened to 8 gal of water to the sack as soon as possible. Grout was forced in until it ran out of the next inlet above, whence water and thin grout were allowed to waste.
6. The grout hose was then connected to this higher inlet, and the procedure was repeated until grout flowed out at the crest opening. Water, air, and thin grout were wasted from this opening until thick grout appeared.
7. The opening was then calked and the "pressure bell," an improvised grout machine made of well casing, was attached to the top inlet. Pressure was then applied and grout forced into the joint according to requirements. If neither, or only one, of the adjacent joints had been grouted, low pressure was used so as not to cause excessive horizontal shear in adjacent blocks. If the adjacent joints had been grouted and a greater joint opening was desired, the pressure was increased until the desired opening was obtained.
8. The pressure bell was kept full of grout, and pressure was maintained until the grout had set sufficiently so that the joint opening would remain constant when the air pressure was relieved. The time required for this was about two hours.

It was found that great care had to be exercised in grouting the arch joints within the zone of upstream overhang. There was of course static deflection of the blocks upstream, which increased with the grout pressure. It was found possible to tilt the heavy abutment blocks at will and to open the joints as desired.

DETAILED OBSERVATIONS ANALYZED

Volumes of grout, shown with other data in Table II, were calculated assuming 50 per cent voids in the cement. The volume of joint space was calculated from measurements of the joint openings at the crest and at the base both up- and downstream. Measurements were made with care at the surface, using thickness gages. The volumes displaced by pipes were included in the joint spaces, which were compensated for batter at the abutment joints.

From Table II it is apparent that the volume of grout exceeded in every case but one the calculated joint space. For some reason the volume of the cement is close to the calculated space volume. The average amount of water used was 9.8 gal per sack, and since this amount of course exceeds the setting needs of the cement, it is probable that considerable absorption by the concrete took place. It was noted that water showed at the surface—especially on the upstream face—along the daily work planes several feet away from the joints for nearly half the lifts on some blocks. Much thin grout and water was wasted from the inlets, and there was also some waste through leaks. Aside from the excess volume of grout, pressures for from two to three hours were maintained to refusal, during which time an average of less than two sacks of cement was used while building up and maintain-

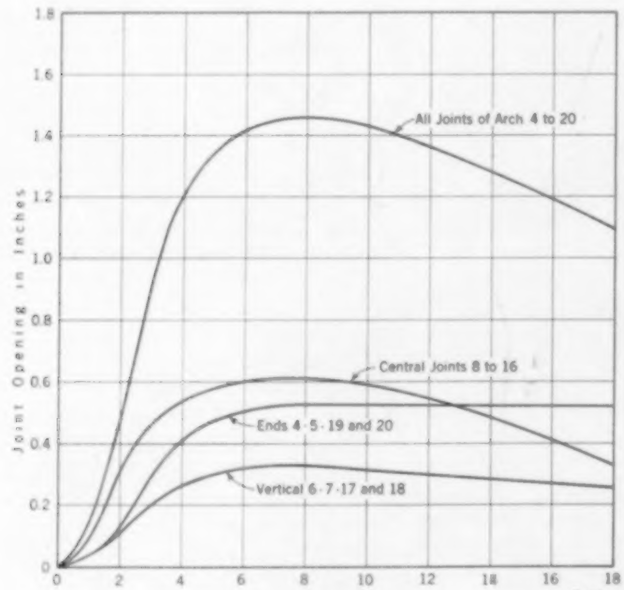


FIG. 2. ARCH OPENINGS AT CREST, VARIOUS COMBINATIONS OF JOINTS

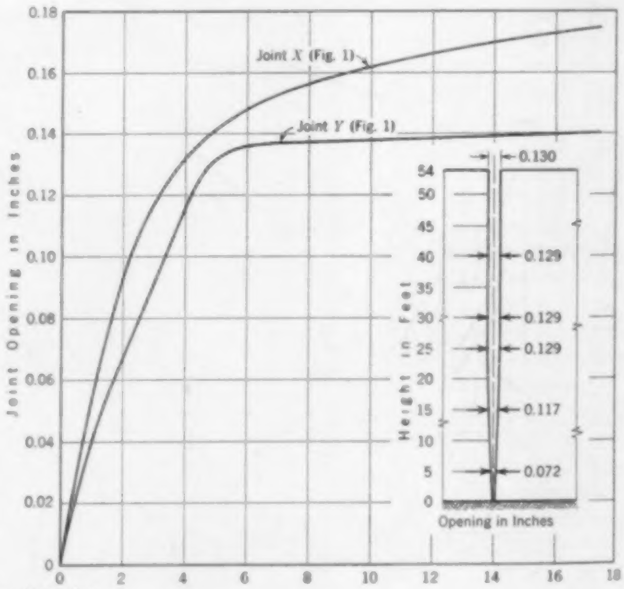
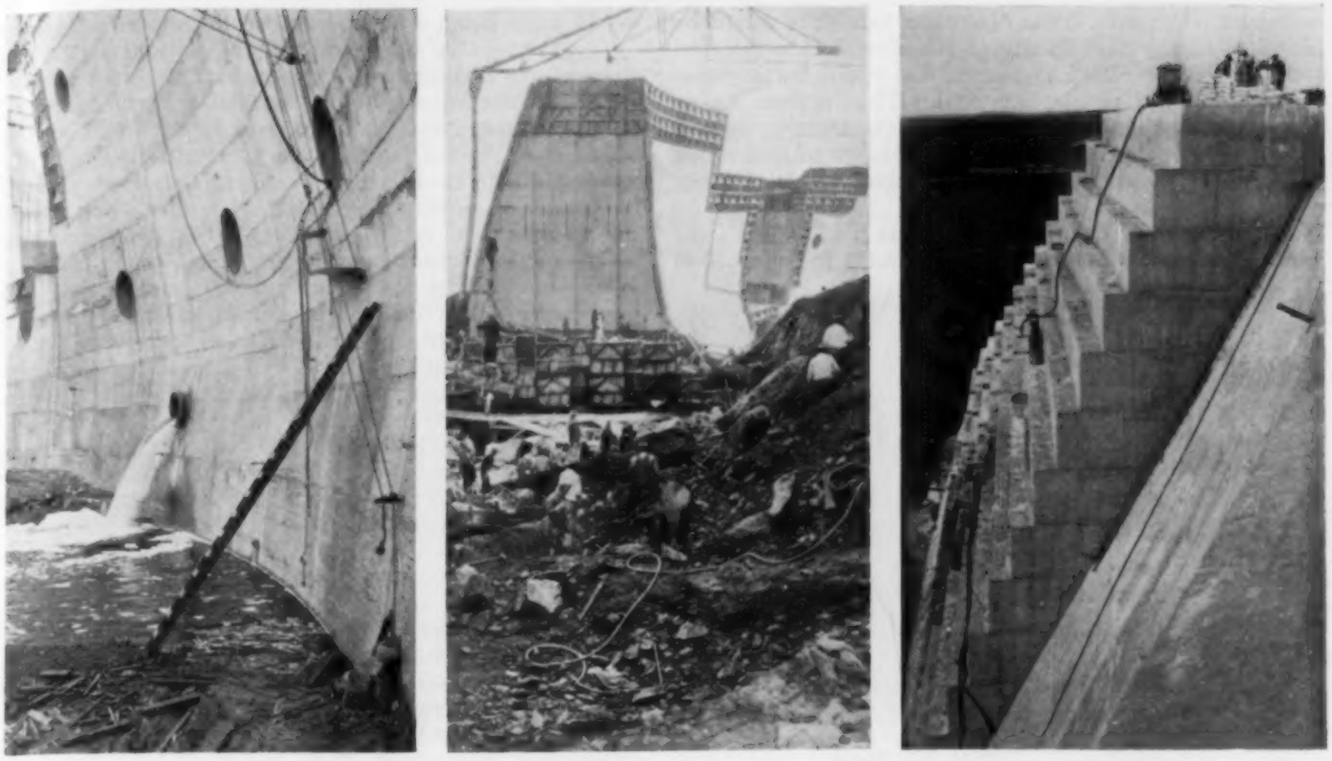


FIG. 3. OPENINGS IN GRAVITY WING WALL AT CREST AND AN OPENING ALONG A TYPICAL VERTICAL JOINT



Views of Hogan Dam: Left, Downstream View near Center of Arch, Showing Overhang. Center, Joint 8 As Seen from Right Abutment (Note Warp of Arch in Erected Sections). Right, Grouting Joint 3 in the Right Abutment. This Joint Has Been Filled to the Upper Inlet, from Which It Is Now Being Grouted to the Crest. Downstream Face of Arch in the Foreground, and Grouting Machinery on Top

ing the desired pressure. This gives ample proof that the joints were full when set occurred.

During grouting the total joint opening at the crest was increased about $^3/_4$ in., which can be credited solely to arch movement. Since six of the central joints could not be sufficiently opened, too much opening and deflection occurred in those joints between the center and the abutments. However, the dam for all practical purposes has been restored so that arch action can begin with load, and nearly 2 in. of shrinkage has been replaced with neat cement.

Table II. Grouting Hogan Dam—Quantities, Joint Openings, and Pressures

Waste and Leakage of Grout and Water Not Deducted

Joint No.	Sacks Cement	Volume of Grout Cu Ft	Calculated Joint Space Cu Ft	Joint Opening, in In.			Grout Pressure at Crest Lb per Sq In.
				Crest		Base	
				Start	Finish		
1	20.0	37.5	25.4	0.070	0.070	0.080	0
2	25.0	46.1	39.0	0.058	0.058	0.095	10
3	48.0	77.3	54.9	0.151	0.229	0.070	65
4	17.0	36.9	13.5	0.063	0.074	0.062	60
5	15.0	26.0	24.7	0.147	0.209	0.060	10
6	15.5	38.4	12.6	0.019	0.070	0.033	80
7	31.0	54.0	30.5	0.133	0.182	0.065	60
8	14.0	25.7	12.6	0.000	0.000	0.051	90
9	28.5	63.3	37.4	0.066	0.119	0.086	15
10	12.0	22.2	15.3	0.005	0.007	0.044	90
11	16.0	30.0	16.0	0.000	0.000	0.054	90
12	19.5	36.8	20.8	0.010	0.021	0.067	85
13	33.0	60.6	21.2	0.029	0.064	0.040	90
14	15.0	29.5	18.6	0.000	0.014	0.062	85
15	39.0	61.2	30.4	0.008	0.117	0.054	25
16	14.0	25.9	15.4	0.000	0.012	0.047	85
17	21.0	34.7	18.6	0.019	0.039	0.057	90
18	28.0	46.6	21.2	0.039	0.084	0.045	85
19	29.0	41.3	32.2	0.143	0.212	0.080	20
20	13.0	25.2	11.6	0.042	0.048	0.040	85
21	23.5	47.1	26.0	0.008	0.082	0.071	60
22	23.0	36.1	36.2	0.161	0.195	0.133	60
Totals....	500.0	902.4	534.1	1.171	1.906	1.396	..

Table III shows periodical horizontal positions of three points on the crest at various stages of grouting. In Fig. 2 are shown changes in the joint openings of the arch at the crest, and in Fig. 3, openings in the gravity wing wall at the crest as well as a typical joint opening in the gravity section from base to crest.

The maximum temperature of the concrete, amounting to 117 F, was reached nine days after placing. Some blocks showed maxima of 100 to 110 F according to placing temperatures and other conditions. The temperature in the arch dropped to about 72 F in eight months including the first summer, and when the dam was grouted temperatures were about 54 F in the arch and 59 F in the abutments.

Some Practical Suggestions

On the right gravity wing, which has an effective length of 310 ft, the total crest contraction was 0.91 in., as measured February 25, 1931. This shows a factor of restrained shrinkage of 0.00024, or approximately 0.003 in. per ft. By using this factor, an estimate was made of the desired opening for each joint of the arch and abutments. In some cases this opening was secured, but not in the central part of the arch where the overhang was material. It is quite possible that these central joints could have been opened with a higher pressure.

Experience with this arch would indicate that where grouting is contemplated, joints in downstream overhanging sections should be provided with copper water seals and also with grout stops of sufficient gage to withstand heavy pressures, both to be tied into the mass so that the sections around the stops could not be blown out. Sufficient pressures could then be used to cause the joints to open. Thus concrete designed to withstand load compression of 500 lb per sq in. might logically be subjected to grout pressures of perhaps 300 lb per sq in.

In the Hogan Dam the central blocks are about 110 ft

in height. For arch dams of greater height, it would be practical and logical to divide the height into isolated areas so that excessive pressures, due to the static grout pressures, would not be involved. Thus a dam 200 ft high could be divided into two separate areas by means of horizontal connections between grout stops and water seals, and both areas could be grouted simultaneously under pressure as desired.

A special finely ground cement was used. The time required for grouting a joint was about 4 hr, and mixes were used according to apparent requirements. Our average mix was 9.8 gal per sack of cement, but if possible less water than this should be used. Not more than 8 or 9 gal per sack is desirable in joints that are opened to 0.02 in. or over. This, of course, depends on local conditions. In any case, more than 10 gal per sack should be used sparingly. At 8 gal per sack, the consistency is like thick cream, and the cement remains fairly well in suspension in a 1/8-in. crack. Above 10 gal per sack, the settling velocities of the cement particles increase rapidly and uncemented spaces may result. By using a fine cement and a thick consistency, proper results are obtainable. Water should not be kept in the joints for any considerable period before grouting, as it is an advantage for the concrete to contribute considerable absorptive capacity.

JOINT 20, LOOKING DOWNSTREAM
Keys and Grout Pipe Shown

TABLE III. MOVEMENT OF ARCH CREST DURING GROUTING

Numbers of Joints Grouted (Additive)	Movement Upstream in Inches: 116 Ft from Right Abutment	Center	116 Ft from Left Abutment	Notes
None	0	0	0	Feb. 4, 1932; center 0.58 in. downstream from designed position; other points unknown
1-7, 9, 21	0.37	....	....	Mar. 2, 1932
13-17	0.52	0.49	0.12	Mar. 17, 1932
18-20, 22	....	0.49	0.12	Mar. 19, 1932
8, 10-12	0.52	0.47	0.12	Mar. 26, 1932
All	0.52	0.43	0.12	Mar. 29, 1932
All	0.52	0.58	0.24	Oct. 4, 1932

CONSIDERING SHRINKAGE IN CONCRETE

Adjustable as this flexible arch may have been to the effect of shrinkage, the value of proper grouting was not overestimated. Stress cannot be transmitted across open joints. The deflection of the crest of this dam would have been excessive had the arc been required to shorten nearly 2 in. to close under load. Only the upper part could close. Below this contact the blocks would have acted as cantilever beams supported at the top and subjected to shear, and the tension at the upstream faces would have been excessive.

It is not uncommon to witness unloaded arch dams and their abutments with cracks or open joints, and it is to be hoped that the longitudinal cracks in gravity dams will not in time divide them into units as they have divided buttresses of multiple-arch dams. Under these conditions load effects are speculative, but it is obvious that such structures cannot act as designed.

Within the last few years cracks in concrete dams have been widely observed, and some confusion in their interpretation has resulted. In a few instances they may be charged to load stresses or a combination of tension from shrinkage and from load, but largely they are first caused by shrinkage, although they may be aggravated later by load stresses. Where they already exist, their order of occurrence does not detract from their importance from the standpoint of load stress. If, however, shrinkage is properly provided for in a structure otherwise well designed, it is probable that cracks from load stresses would rarely occur. More conservative designers usually prescribe larger dimensions, which, however, only aggravate shrinkage effects.

It is obvious, therefore, that provision for shrinkage is an essential part of design. Advanced methods of design and construction reflect increasing concern over the vitiating and destructive results of shrinkage. Changes in placing methods which allow reduction of water-cement ratios coupled with the use of special cement, as practiced at the Morris Dam, and temperature control, as initiated at the Boulder Dam, are effective means of reducing shrinkage.

Reduction of shrinkage is a matter of degree only; hence the need for contraction joints remains. Although a minimum of shrinkage is beneficial to the mass, it is not of particular advantage as regards the joints themselves, since proper grouting of a small opening is a more uncertain procedure than proper grouting of a relatively large one.

A general fault in the past has been that monolithic units have been too long in at least one direction. Higher strength concrete and reduced shrinkage will aid in correcting this fault. However, mass concrete shrinks first at exposed surfaces, where tensile stresses may become extremely high and the tensile strength may be exceeded. Once a crack starts, "tearing" action results, and the internal tensile stress must be low if the crack is not to penetrate deeply.

An estimate of the interior opening of a joint is only approximate when the crack is gaged at the surface. Without better means of measurement, however, such gaging does give a usable measure of a condition, and the estimate of shrinkage so deduced is reasonable. That it is possible and desirable to provide a reasonable spacing of joints and to grout them to advantage has apparently been demonstrated fairly on this dam, although proof is lacking since the dam has not yet been fully loaded. This principle is also applicable in the construction of dams of other types, where the length of the units becomes excessive and no other provisions for shrinkage have been made.

This dam is named for W. B. Hogan, city manager of Stockton. Lyle Payton is city engineer and to him grateful acknowledgment is made for assistance in obtaining data for this article. Hogan Dam was designed by Fred H. Tibbetts, M. Am. Soc. C.E., and constructed by Bent Brothers. W. S. Post, Assoc. M. Am. Soc. C.E., was resident engineer, and I was assistant resident engineer.

Studying Traffic Capacity by New Methods

Photographic Surveys of Automobile Travel on Ohio Roads Are Illuminating

By Bruce D. Greenshields

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For years the standard method of taking traffic counts has been to employ observers with stop watches and tally sheets. The new method devised by Dr. Greenshields utilizes a motion picture camera designed to take pictures intermittently, at frequent intervals. Superposed on each exposure is a log record showing the exact time, data, and other details. Besides this scale of time, a scale of distance is fixed by markers on the road itself. Such observations on 22,000 vehicles were taken in Ohio during the summer of 1934 and have since been analyzed in detail by groups of 100 cars. As a result, new relations between speed, spacing, and total density have been found. Up to a density of perhaps 600 vehicles an hour, there were no delays due to traffic. In every instance the average unhampered speed was from 42 to 44 miles an hour on pavements. On two-lane roads the maximum capacity was found to be about 2,300 vehicles an hour, at a speed of about 22 miles an hour. This method of making a graphical tally, with its valuable potentialities, should prove a boon to engineers in the making of traffic analyses.

Until recently traffic surveys have been inadequate for determining the capacity of a roadway of a given width and type. The count and stop-watch system cannot be adapted to obtain complete information, especially if numerous automobiles are moving in opposite directions at a variety of speeds. The photographic method of studying and analyzing traffic problems, as here described, is comparatively new. Thus far it has proved highly successful in overcoming the difficulties of the previous systems.

For one thing, the eye of the camera is accurate, and the instantaneous records, or pictures, can be made the basis of a complete study. The pictures taken by a 16-mm motion picture camera not only show the number of cars passing in a given time, but also reveal the type of cars, the paths of their movements, and their rate of travel. A few simple methods of interpretation disclose the desired information.

To take the pictures, the camera should be approximately 300 ft from the roadway and if possible at right angles to it, thus bringing about 125 ft of the highway within range of the lens. By means of a clock arrangement with an electric switch, the pictures are then taken automatically. For convenience, the time interval between pictures is arbitrarily set at 88 per min, so chosen because a vehicle traveling 1 mile per hr would advance 1 ft in $^1/_{88}$ min.

White markers are placed on both sides of the road, usually 50 ft apart longitudinally, to give a scale for the center line of the road. In the case of a two-lane roadway, the scale can be satisfactorily shown when the films are projected by vertical parallel lines equally spaced, which are drawn on the screen. Thus the same scale lines are used for all the films, the throw of the lantern being changed so that the scale lines will fit films taken at different locations. For multiple lanes or where the pictures are not taken at right angles to the road, it may become necessary to construct a scale with converging lines. But this is always possible if enough marked points are in the field of view.

In addition to the markers, each picture shows a bulletin board and clock in the immediate foreground, giving the time, date, location, type and width of pavement, film number, time interval between frames, and weather conditions. Thus the pictures constitute a complete and permanent record which may be analyzed at any time or re-checked for information that may have been overlooked in the first analysis.

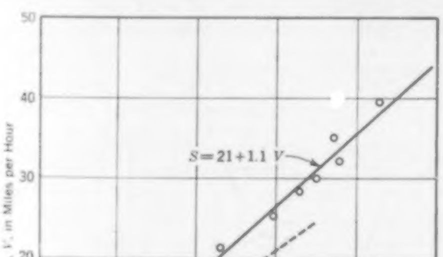


Fig. 1. Speed and Spacing of Vehicles

Point of Zero Velocity Is Average of 143 Observations. Each Other Point Is Weighted Average of 99 Observations. From *Proceedings*, Highway Research Board, 1933, Page 393

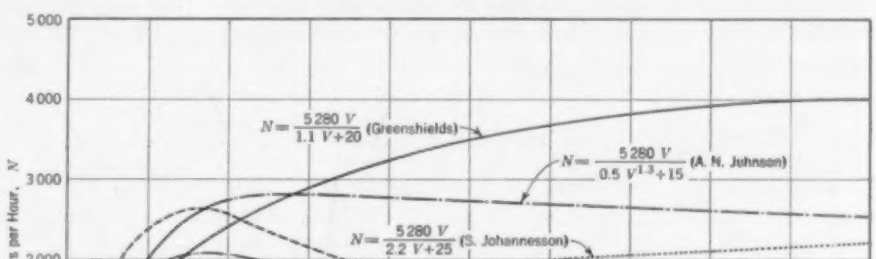
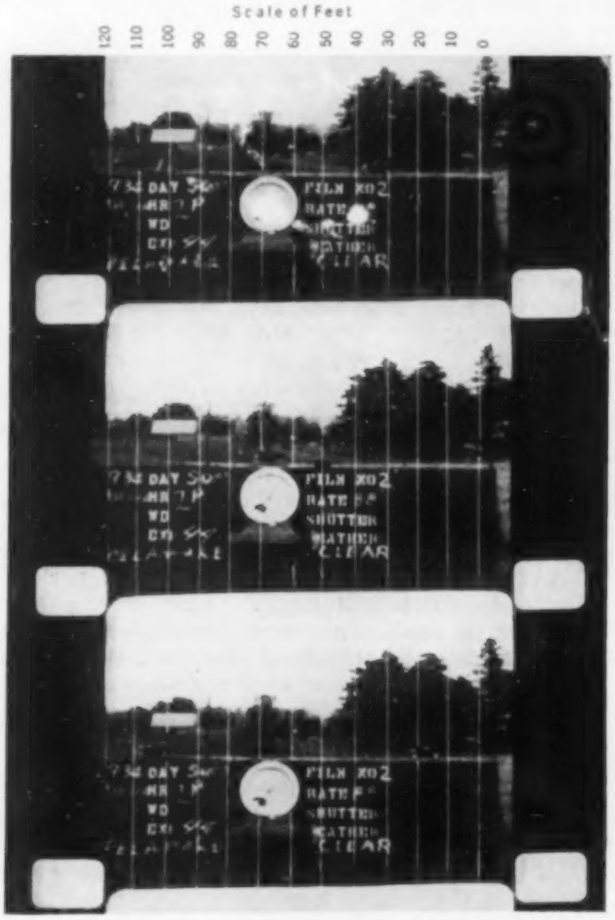


Fig. 2. Graphic Comparison of Formulas for Determining the Relation Between the Number of Vehicles Passing a Given Point and Their Rates of Speed

Reproduced from *Proceedings* of the Highway Research Board, 1933, Page 394

A reproduction of three consecutive photographs is shown. In the first, at the top, the rear car appears at position 38 on the scale. In the second picture it is at position 72 and has advanced 34 ft, which means that it



CONSECUTIVE VIEWS ON U. S. 23, AT A POINT 1.0 MILE NORTH OF DELAWARE, AT A RATE OF 88 PER MIN

Bulletin Board with Clock Appears in Lower Half of Each Photograph. Vertical 10-Ft Lines Show Distance Traveled

is traveling 34 miles an hour. From the first picture it is seen that this car is 82 ft behind the one in front, measured from center to center. From the speed and time at which the cars appear the spacings may be calculated even though the cars do not appear in the same picture.

Obviously the usual speeds and density of traffic are a measure of the comparative ability of various types and widths of highway to facilitate traffic. It is evident that roads permitting the highest available speeds will carry the maximum amount of traffic.

A typical set of data representing free-moving traffic on an uncongested roadway was obtained on State Route 2 (U. S. 6) 4.9 miles east of Vermilion, Ohio. This section of new concrete highway is 30 ft wide. Profilometer readings showed an average of only 12 variations per mile in excess of $^1/_4$ in. in 10 ft. This road is straight, and the view is unobstructed for a long distance, so that it provides an ideal place for high speeds. Its traffic shows the normal tendencies of travel, or what the average driver does on a smooth roadway free from interference from other vehicles. At no time did the road carry sufficient traffic to cause congestion. The data are given in Table I.

TABLE I. SIGNIFICANT TRAFFIC OBSERVATIONS ON U. S. 6, EAST OF VERMILION, OHIO

Density in Vehicles Per Hr	Number of 100-Vehicle Groups	Mean "Smoothed" Speed	Percentage of Trucks	Percentage Traveling in One Direction
270	1	42.5	6.0	48.0
308	2	41.6	7.5	54.5
323	6	42.8	5.7	58.9
330	3	40.7	8.6	56.9
349	14	43.7	6.0	54.1
364	7	43.5	8.9	54.7
389	16	42.5	8.0	53.6
410	6	42.0	8.7	53.0
441	11	40.7	7.6	54.0
464	1	43.2	9.0	55.0
509	1	40.7	8.0	57.0
Av. 379	Sum 68	Av. 42.4	Av. 7.5	Av. 54.4

Averages were computed for the total 68 groups. The term "mean smoothed speed" needs explanation. This speed was taken from a curve so drawn on arithmetic probability paper as to give a "smoothed" value. It will be noted that the vehicles were studied in groups of 100 each. If the number passing in any particular time interval, such as 15 min, is taken as a unit for study, it may be found that there are 50 passing in one case and 200 in another case. Fifty vehicles are not sufficient to give a true average, and their performance should not be compared with that of the 200. By referring to the table it is seen that a group of 100 vehicles gives about the same average speed as a much larger group. Therefore such groups were deemed satisfactory for comparison.

On a roadway the traffic pattern shows vehicles travel-

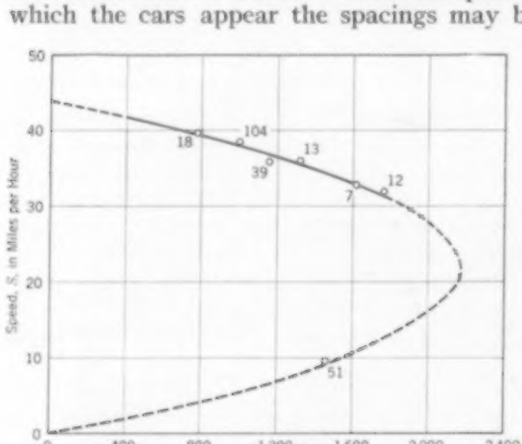


FIG. 3. RELATION BETWEEN SPEED AND DENSITY PER HOUR, ON TWO-LANE HIGHWAYS IN OHIO

Numbers on the Curve Show the 100-Vehicle Groups Observed for Each Point

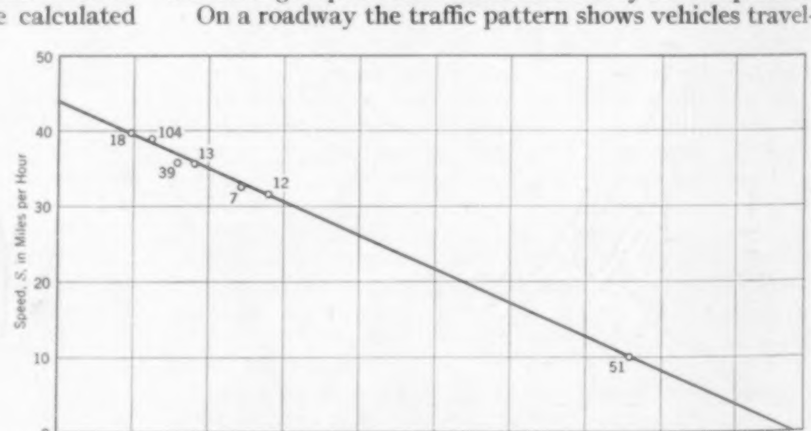


FIG. 4. RELATION BETWEEN SPEED AND DENSITY PER MILE, ON TWO-LANE HIGHWAYS IN OHIO

Numbers on Curve Show the 100-Vehicle Groups Observed for Each Point

ing at diverse speeds and spacings. To take this variation into account, the 100-vehicle groups were selected so as to secure what is known as a "moving" average. For the purpose of comparison and analysis, one sample of 100 cars is just as good as any other sample. Suppose that one group of 100 vehicles numbered from 1 to 100 has just been observed. If the first ten cars of this group, which may have any speeds and any spacings, are dropped and ten new ones added, the new group would not have the same characteristics as the first, even though the same 90 cars appear in each group. Plainly the cars in this second group are numbered from 11 to 110, or a third group would be numbered from 21 to 120.

Observations were taken at various locations in Ohio on brick, concrete, and asphalt pavements, mostly of two-lane width. Profilometer readings showed that

CAMERA IN OPERATION, WITH BATTERY
Bulletin Board in Field of View Indicates Time and Other Data

bumps in excess of $^1/_4$ in. in 10 ft ranged in number from 12 to 492 to the mile. In every case where the surface was firm and dry, however, the average free speed was between 42 and 44 miles per hr. Evidently a certain

TABLE II. DISTRIBUTION OF VEHICLE SPEEDS

Composite Data from Twenty-Four 100-Vehicle Groups, on U. S. 6 East of Vermilion, Ohio. Average Smoothed Speed, 43.0 Miles per Hr; Percentage of Trucks, 6.0

Speed in Miles per Hr	Percentage of Vehicles Traveling at Equal or Lower Speed	Speed in Miles per Hr	Percentage of Vehicles Traveling at Equal or Lower Speed
10	0.01	45	59.0
15	0.1	50	79.0
20	0.6	55	91.0
25	2.5	60	97.0
30	8.0	65	99.2
35	20.0	70	99.8
40	38.0		

amount of roughness has little effect on average speeds. Speeds of over 80 miles per hr for passenger cars, of 60 miles per hr for light trucks (net rate capacity of $2^1/_2$ tons or less), and of 50 miles per hr for heavy trucks were recorded. The average speed of the buses recorded was 41.6 miles per hr. On the other hand, an investigation of the speeds on gravel roads, in connection with a study in Michigan made in the summer of 1933, gave an average speed of 32 miles per hr, showing that a loose or unstable surface causes loss in speed.

The study likewise furnished information on the distribution of vehicle speeds for different densities, as shown in Table II.

HOW SPEED AND SPACING ARE RELATED

In securing the maximum theoretical capacity of a highway, the minimum spacing at which vehicles travel at different speeds is important. It may be reasoned, logically no doubt, that a driver maintains a space between his own car and the car ahead sufficient to permit

HIGHWAY TRAFFIC FILM PROJECTED ON SCREEN
For Study by FERA Students at Denison University. Note Double Exposure of Pictures

a safe stop should the other meet with disaster. Whether or not he does this can be found out only by observation, such as is possible by the photographic method.

In the investigation of speed and spacing of vehicles, an attempt was made to take pictures only of groups of cars that seemed to be moving at controlled speeds and to exclude all observations where the relative velocity of the front vehicle differed by more than 5 ft per sec from that of the one following. It is evident that on a heavily traveled highway the tendency of traffic is to move in crowds, and that the leading vehicle controls the speed of the entire group. At lighter densities, it is harder to determine whether the speeds are affected by congestion.

Observations secured from 6,000 pictures of spacing for each two-mile variation in speed, averaged and plotted on rectangular cross-section paper in Fig. 1, seem to be fairly well represented by the straight-line equation,

$$S = 21 + 1.1\,V \quad [1]$$

where S equals the spacing of vehicles from center to center, in feet, and V equals the velocity in miles per hour. The lower curve in Fig. 1 represents data taken where speeds were slow and in city traffic. This indicates that different driving conditions may affect spacing.

In an effort to rationalize Equation 1, it may be assumed that the first term, 21, is the spacing in feet at which vehicles come to a stop. It has been observed that vehicles waiting for traffic lights to change are spaced at approximately this distance.

If the speed, V, is expressed in feet per second in place of miles per hour, the coefficient of V in Equation 1 becomes 0.75 instead of 1.1. It is interesting to note that this is about the average time in seconds that it takes a driver to bring his brakes into operation when the occasion arises. In other words, it is the average brake-reaction time. The equation means then that the variation in the average minimum spacing between vehicles

depends on reaction time and not on the braking ability of the vehicle. Since deceleration after the brakes have been applied is practically constant, this minimum spacing is sufficient unless the leading car should come to a sudden stop. In such cases there is often a collision.

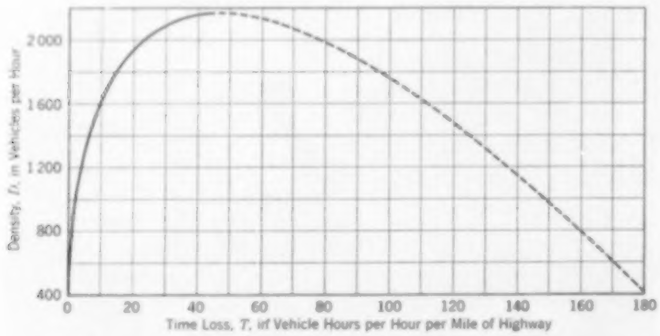


FIG. 5. TIME LOST BY VEHICLES DUE TO REDUCED SPEED ON A CONGESTED TWO-LANE HIGHWAY

Calculation of the maximum number of cars that could go over a highway, all traveling at the same speed and with the average minimum spacing, gives the theoretical maximum capacity shown by the upper curve in Fig. 2. For instance, if all cars were moving at 40 miles per hr, the number that could pass on one lane in one hour would be approximately 3,200. This is never realized except for very short periods of time. The curve does prove, however, that increased average speeds mean increased highway capacity, and that the reason highways do not have a greater capacity is that in any traffic stream of any extent there are always enough slow-moving vehicles to decelerate all the others. Other previously derived curves, also shown in Fig. 2, indicate the considerable variation that may exist between a theoretically derived measurement and one based on actual observations.

What seems to be the proper method of measuring highway congestion or the retardation of vehicles due to heavy traffic is to take actual measurements of the speeds at different densities. A comparatively large amount of such data was collected in Ohio during the summer of 1934 by the Traffic Bureau of the Ohio State Highway Department. This study, based on the observation of over 22,000 vehicles, was analyzed in 1,180 groups of 100 vehicles each. The results show that as the density in vehicles per hour on a two-lane highway increases beyond 400 to 600 vehicles per hour, the average speeds of all vehicles decrease. This density is what may be termed the "free-moving" or "working" capacity of the highway. In other words, 400 to 600 vehicles per hour marks the beginning of congestion.

In Fig. 3, arrived at by plotting the density, D, or the number of vehicles passing in one hour, against recorded speeds, is given the average speed corresponding to any density. For example, at a density of 1,600 vehicles per hour the speed is equal to 33 miles per hr. Then, as the speed continues to decrease due to crowding, the density increases proportionally up to approximately 2,200 vehicles per hour, which represents the maximum carrying capacity of the road. If crowding continues, both speed and density decrease until at a speed of 10.5 miles per hr, the density is again 1,600 vehicles per hour. For a short time a roadway may become so packed with vehicles that all must stop. The density then is zero.

If the speed is plotted against average spacing, the curve in Fig. 4 is obtained. This spacing may be expressed as D', the number of vehicles per mile of pavement. The spacings may be secured from observation, but D' is also the result of dividing the density, D, by the average speed. For example, if the density, D, is 400 vehicles per hour, and the average speed is 40 miles per hr, then the number of vehicles per mile is 10. That is, $D' = 400 \div 40 = 10$. The curve for D' in Fig. 4, drawn from the same data as Fig. 3, is a straight line. Since a straight line is fixed by two points, it is theoretically necessary to have data for only two traffic conditions. Owing to the fluctuations in traffic movements, however, conclusions should be drawn from ample data. Although the curves in Figs. 3 and 4 would not hold for other localities, they may form the basis of estimates.

Economically speaking, congestion is costly. The time loss, in vehicle-hours for each hour on a mile of pavement, resulting from the speed drop shown in Fig. 3, is plotted in Fig. 5. At a density of 400 vehicles per hour, corresponding to the free speed of about 42 miles per hr, there is no time loss. The great waste is shown to occur as congestion takes place, especially in aggravated form.

Since time has an economic value, as proved by the fact that people are willing to pay for the saving of it, it becomes the obligation of highway commissioners to study traffic congestion. By so doing they may determine when a roadway should be widened to meet the needs of the public in reference to economy in time as well as to safety.

FURTHER APPLICATIONS FEASIBLE

Use of the photographic method is reasonable in cost, with the price of 16-mm films on 50-ft rolls about $3 each. A roll with its 2,000 single frames is sufficient to record the movements of about 800 cars. More can be recorded if the traffic is dense enough for more than one car to appear in each frame or picture. An expensive camera is not necessary but it is desirable, for the better the camera, the better the pictures.

Accident prevention has not been mentioned, but all traffic movements have some relation to accidents. The minimum spacing maintained by drivers does not allow time for stopping should the car ahead come to a sudden halt. Slow-moving cars cause not only congestion but also accidents when faster vehicles attempt to pass. Perhaps on busy highways everyone should be required to travel at the same speed.

This brief report has shown that much valuable information about traffic behavior may be gained by the proper approach. Other phases of the subject immediately present themselves for investigation. How do curves, horizontal and vertical, affect speeds? What is the sight distance and the clearance on the opposite lane required for passing a car ahead? Without doubt, further research is not only desirable but necessary if knowledge of traffic is to keep up with the increase in traffic problems. Highways, built to last at least 20 years, are far behind the perfection of the modern motor car, yearly improved and guaranteed to have a speed of from 80 to 100 miles per hr. Safe driving is still subject to the mental perceptions and physical limitations of drivers.

This study has been carried on under the supervision of H. E. Neal, traffic engineer, and J. J. Darnall, superintendent of traffic surveys, both of the Traffic Bureau, Ohio State Highway Department.

Part of the general substance of this article was presented before the Highway Research Board—at the 1933 annual meeting, published under the title, "The Photographic Method of Studying Traffic Behavior," in the *Proceedings* of the organization, Vol. 13 (1934), page 382; and before the December 1934 annual meeting under the title, "Studies of Traffic Capacity," to appear in Vol. 14.

Modern Engineering Colleges

A Study of the Place of the College in the Engineering Field

By N. W. Dougherty

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THE last few decades have witnessed remarkable developments in the technical and professional schools of the country. In contrast with conditions a century ago, when engineering graduates were viewed with distrust by the profession, it is increasingly difficult today to enter the profession except by way of the engineering school. This new importance of engineering colleges and the part that they must play in training and inspiring the present generation of engineers to take their place in directing the activities of modern life are here ably discussed by Professor Dougherty.

A CENTURY ago there was little or no engineering education in the United States. Colleges devoted themselves to the branches of study now taught in high schools and the liberal arts colleges of universities. Law, medicine, and the ministry were considered learned professions, but the training required for admission to them was far different from what it is today.

The majority of those who practiced engineering were recruited into the ranks through the "school of hard knocks" or through a system that paralleled apprenticeship in industry. Engineers were practical men. They knew from experience, if they knew at all. A few of them were modern enough to make models of designs and to test the models before they executed the designs. These early practitioners looked with questioning on the first crops of engineering graduates. They had learned by trial and error, by experience, and by failures, and they were hesitant to take theoretical men into their midst.

As the graduates of engineering schools increased in number and became more efficient in the tasks assigned to them, they dominated the whole profession. Today the way to engineering practice is indeed circuitous when it is not through an engineering school. In the future the path will be even more difficult to travel.

Nor is it strange that this should be the case. Engineering is based upon the accumulated knowledge of the past, upon the fundamental sciences that have undergone marvelous development during the last half century, and upon a professional attitude best acquired in an atmosphere of applied science. Although accumulated knowledge may be imparted by a good teacher, science can be mastered only by diligent study, and the proper professional attitude can be attained only by mastery of scientific principles. Thus much of the needed equipment of the engineer must be acquired in a professional school. The engineering college has therefore become the gateway to the profession. A sign may well be written over its doors: "If anyone would become an engineer let him enter here."

TEACHING IS PRIMARY

If the college accepts this responsibility it must accept it as a sacred trust. It cannot point the way to engineering greatness and follow the fads of the moment. It must apply itself diligently to finding out what a young engineer needs to know and must see to it that the necessary knowledge is imparted to him. Therefore its primary object must be teaching. The college may engage in many activities, but if it departs from the path of preparing young men for the profession it has lost its principal reason for existence.

The faculty of the college must study the profession and try to make the students understand it, so that they will leave the college with an engineering attitude, an engineering perspective, and a zeal for their work. They will develop best in an atmosphere of science, of professional accomplishment, and of sympathetic understanding. After teaching young engineers the fundamentals of the profession, the college may consider the possibility of doing other things. Until its primary purpose is accomplished, however, it has no right to engage in other activities, except as adjuncts to teaching. Often, fortunately, the extra-curricular activities of a college enhance its teaching and increase its ability to render service to the profession.

PROFESSIONAL DEVELOPMENT

Engineering colleges must be sources of inspiration for professional development. In an age that is changing from day to day, the profession cannot stand still. It must meet new problems and solve them. However, it is not enough for the profession to solve problems and let others exploit its solution; the profession must "follow through" to a public recognition of its merits.

It is time that engineers asserted themselves in the councils of the community, the state, and the nation. They are more conversant with the trend of the age than any other group of men, and they must assume responsibility for management. The group as a whole must acquire a professional attitude and a professional consciousness. Credit must be given where credit is due, and the engineering college may well take the lead in recognizing achievement. By recognition I do not mean cheap publicity, but rather a dignified appreciation of worth.

The college must cooperate with other agencies in working for the betterment of the profession. Engineers do not subscribe to the methods of the closed shop. It is their belief that the members of a profession are entitled to public recognition that will give them their share of the products of their efforts. The conditions under which they work should be reasonable; their compensation should be adequate; and they should have a right to their own thoughts. These things can be promoted by organized effort on the part of the profession, and the college should be instrumental in supplying leadership.

To create and maintain a profession its members must have a high standard of professional conduct and be of unimpeachable integrity. It has been suggested that engineers are "too honest." This is not true, but if the majority are honest they must find a way of keeping the unscrupulous from masquerading behind their integrity. The colleges should participate in the movement that is under way for establishing standards for admission to the

profession and fixing the standards of advancement. By this we do not suggest that they undertake to set aside the law of supply and demand for services, but rather that they assist in establishing milestones in professional progress.

Engineers are protecting themselves by law. For example, the engineers of many states will not allow an interloper to desecrate their good name. This is as it should be. The colleges should join hands with the law-enforcement agencies and with technical and professional societies to make engineering respected—first by the profession itself and then by the public at large.

THE COLLEGE A REPOSITORY OF KNOWLEDGE

The engineering college must be a repository of the accumulated knowledge of the profession. It must maintain a library that will give to all who are willing to learn an opportunity to do so. We cannot think of American civilization without libraries, without magazines, and without the public press. Likewise, it would be folly to undertake to train initiates into a profession without putting within their reach the accumulated knowledge of that profession. One of the primary functions of engineering education is to train both young and old in the use of printed material. If this function is neglected, our profession will become static.

Not only must the college be the storehouse of learning, it must also be productive of new knowledge. This means contact with the past, industry in the present, and hope for the future. Engineering scholarship that is not productive will stagnate and lose its influence in modern industry. There is only a minor place in teaching for the instructor who is like a parrot or a phonograph. Such teachers can keep their hearers well informed but they cannot make their teachings vital. Students exhibit more enthusiasm for knowledge when they are working with a dynamic personality. They are interested in what Newton thought and did, but they would like to see a small-scale Newton in action.

Although an engineering college may be a museum, it must be primarily a laboratory. The workshop, the laboratory, and the design room are the places in which to teach young engineers. Since the engineer's life is spent in the market place, in the factory, on the outposts of civilization, he must be a man of action. He must let the dead past bury its dead and push on to new frontiers, new processes, new designs, and new methods.

IMPORTANCE OF RESEARCH

The engineering college should promote research. It can afford to seek the truth for truth's sake. The profession is based on the application of the laws of nature to methods and materials. Therefore there should be room in it for the search for truth—not for the dollars it may bring, but for other and intangible values.

All the research energies of the college need not be consumed in search for abstract truth. It is no disgrace to make new and useful articles. On the contrary, one of the most pressing needs of the day is intelligent diversity of production, and to make such production possible there must be new inventions. As a case in point, it may be said that the development of the automobile was a godsend to the last two decades. It took laborers from the farm and from other over-expanded industries and gave them a new kind of work. If some similarly useful invention could be developed, the process of manufacturing it would break the back of the depression.

Not only may the university laboratory discover truth and encourage practical developments, but it may also be a source of inspiration to the student. Some engineers need intensive research training, but the number is comparatively small. All, however, need to know the methods of research and the proper attitude toward research problems. This attitude dares to break away from all past tradition and follow where the path may lead. To accomplish his tasks the worker must keep an open mind, measure his own faults, and weigh his findings. Prejudice cannot enter, preconceived ideas must perish, and each answer must stand on its own merits. Charles F. Kettering has said that "Research is finding out today what you are going to do when you have to quit what you are doing now." This is the definition of commercial research. The colleges, in cooperation with interested agencies, may well engage in solving the problems of commerce and industry. By so doing they will serve many ends. They may find the answer to some of the problems of industry; they may develop new truths; and they will surely demonstrate to the students correct engineering attitudes.

It is as true in the physical world as in the spiritual: "Seek and ye shall find, knock and it shall be opened unto you." The measure of success may be forecast by the earnestness of the seeking. The answer may be negative, but if it is reported it may be of equal value with other positive answers.

TECHNICIANS IN PUBLIC WORKS

The engineering college should be a consultant on public works and public policies. The time has arrived when the public needs technicians rather than politicians. In an age of machinery and remarkable production the man who understands machines should be consulted.

Governments are entering the fields of public service. Where the paths will lead, only the future can tell. For such ventures as irrigation, power production, highway building, water supply, sanitation, river improvement, and erosion control, engineering knowledge is imperative. The educational system of the United States is primarily public, even though much of it is privately endowed. The colleges therefore have a duty to the public, and this duty calls the endowed school as well as the state-supported institution. Wherever possible the acquired and accumulated knowledge of the engineering colleges should be available to the general public. Although under the present economic arrangement the college should not be made to compete with its former graduates, the public should certainly not be denied its services.

If present trends continue we are at the beginning of an era of public expenditures for needed services. Some protest that these developments are a form of interference with private enterprise. However, when it is noted that private enterprise employs engineering graduates on these services, one wonders if these graduates could not be just as loyal if their employer were the general public.

Someone in the country must be able to advise the public on service development without receiving pay from interested capital or fearing possible disapproval at the polls. Who is better fitted for this task than able engineers working in the engineering colleges in a democratic country?

STATESMANSHIP IN INDUSTRY

Last, but not least, dare the engineering colleges assume the statesmanship of industry? Can the engineer leave his machines and devices long enough to understand the intricate human relationships involved in his work? Must he still produce more than we can consume, construct more than we need, and build machines for

every activity known to man? If someone does not apply real statesmanship to our economic woes, we will have to let our machines become idle and revert to broad backs and strong hands for industrial production.

In the future we must apply economics to our engineering. We must follow production through distribution to consumption. We must make the things that are needed and see to it that they come to the hands that can use them. It denotes lack of economic adjustment and, to that extent, lack of civilization to produce an abundance of food and clothing and yet have hungry and naked people in the community.

Those who know industrial history and are familiar with industrial organizations must be charged ultimately with policies. The engineering colleges should try to draw aside the curtain of the future, compare conditions with those of the past, and warn against future disaster. It certainly indicates a lack of elementary knowledge to follow paper gains and paper riches when the whole history of the past has shown no way to carry values over from one generation to the next except in useful things. A factory for making buggies may have cost a million dollars, but when the automobile came it lost its value unless it could be used for manufacturing other vehicles. Useless machines have no value, except as scrap, and it is time private capital learned this lesson.

It is to be hoped that the engineering colleges and their graduates will assume a new order; that they will dare to say when machines may be manufactured as well as how; that they will fix the policy of public works as well as supervise the construction of them; and that they will become consultants on new methods and not technicians only. Although engineering colleges are not endowed with universal knowledge or occult powers, many times their voice has been feeble or scarcely audible when they should have spoken in tones of thunder. Engineers should not abandon their present rôle of "master builder" for a new rôle of prophet and sage, but it is essential that they direct their own energies and assume responsibility for their productions. They must no longer be the "hired help" of production; rather they must take their places in the councils of industry.

Let us then picture the engineering college as the gateway to the profession. Its faculty should comprise excellent teachers, who are in accord with the ideals of the profession and steeped in its wisdom and knowledge. They should be productive scholars both in theory and practice, and finally, they should be able to see the position of industry in modern life. With such a faculty, aided by a collection of books and by well-equipped laboratories, the college may assume an inspiring rôle in the engineering field.

ENGINEERS' NOTEBOOK

From everyday experience engineers gather a store of knowledge on which they depend for growth as individuals and as a profession. This department, designed to contain practical or ingenious suggestions from engineers both young and old, should prove helpful in the solution of many troublesome problems.

Fillers for Brick Pavement

Field Tests in Ohio to Prove Value of Various Types

By R. R. Litehiser, Assoc. M. Am. Soc. C.E.

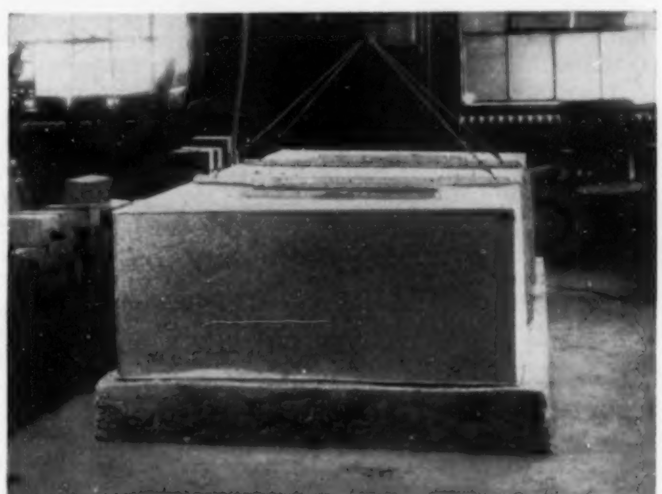
Chief Engineer, Bureau of Tests, Ohio Department of Highways, Columbus, Ohio

HIGHWAY engineers and research departments of concerns furnishing highway building materials are faced with a problem of considerable magnitude owing to the large volume of automobile traffic that the highways are called upon to handle, not only rapidly but safely. Fundamentally, a surface must furnish a firm grip for tires under all conditions. Practically all paving materials are available in Ohio and have been used to a considerable extent but this article will discuss only one, paving brick.

Vertical-fiber paving brick, such as are now standard, have an inherently gritty surface. With the advent of the practice of removing excess filler during construction, it has become possible to expose the brick surface in its entirety in the finished pavement. However, the bituminous fillers in general use exude to a marked degree, and after the first summer's traffic are apt to cover the brick surface to the extent of as much as 25 per cent, diminishing the initially gritty area by that amount.

Quite generally the desirability of a filler that will be less exuding, if not entirely non-exuding, has been recognized. Road users are indebted to the work done during the past year by the Research Bureau of the National Paving Brick Association, at the Engineering Experiment Station of Ohio State University, for the first important developments in this direction. These developments appeared sufficiently promising to warrant trial at full scale in the field.

Accordingly the Ohio Department of Highways will supplement two previous studies of brick paving design



Metal Hood Covering Brick Pavement Test Panel
Thermostatically Controlled Electric Heat on Definite Schedule

and construction with a third in 1935. This field study will include cement grout and bituminous fillers and a new filler known as "plastic sulfur." There will be 13 different fillers, each one used on a section of pavement

450 ft long. The work was placed under contract in January 1935, and the test sections will be completed during the summer.

VARIETY OF FILLERS TO BE USED

In the following discussion of the characteristics of the 13 fillers, Ohio highway asphalt filler will be used as the basis for comparison inasmuch as it represents present standard practice. This is an asphalt of the following characteristics:

TEST PANEL OF PLASTIC SULFUR FILLER
After Heating for Seven Days at 130 F

Specific gravity, 25 C/25 C	not less than 1.00
Flash point	not less than 260 C
Softening point (ring and ball)	not less than 75 C
Penetration:	
At 0 C, 200 g, 60 sec	not less than 15
At 25 C, 100 g, 5 sec	30–45
At 46 C, 50 g, 5 sec	not more than 90
Ductility at 25 C	not less than 4 cm
Loss at 163 C, 50 g, 5 hr	not more than 1.0 per cent
Total bitumen soluble in CS_2	not less than 99.0 per cent
Bitumen insoluble in carbon tetrachloride	not more than 1.0 per cent

A wide variety of test fillers will be tried out in the other sections. These may be briefly described as follows:

1. An asphalt filler, made from a mid-continent crude oil. This filler has a somewhat higher softening point by the ring-and-ball method, from 85 to 96 C, and less susceptibility to temperature variations than the present Ohio standard. The penetration at 46 C, with a 50-g weight for 5 sec for this filler is to be not more than 65.

2. A blended asphalt filler (65 per cent mid-continent base, 35 per cent asphaltic base) of the low temperature susceptibility type, having a penetration at 46 C with a 50-g weight for 5 sec, of not more than 47. Its softening point by the ring-and-ball method will be between 101 and 110 C.

3. A blended asphalt filler somewhat similar to No. 2, differing, however, in that it will contain 20 to 30 per cent of finely divided mineral matter separately added in the process of manufacture.

4. A natural lake asphalt filler having a comparatively low softening point, 50 to 60 C by the ring-and-ball method, and containing from 20 to 30 per cent naturally incorporated mineral material.

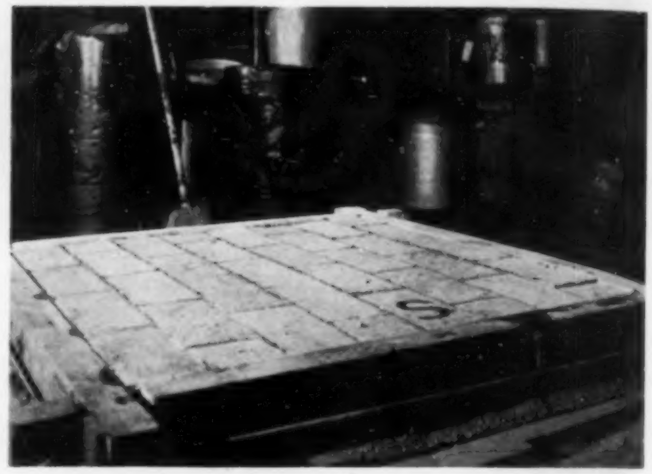
5. Two asphaltic base fillers to be made from a crude oil having a 100 per cent asphaltic base. One is similar in characteristics to Ohio highway asphalt filler, while the other has a lower temperature susceptibility, that is, its penetration at 46 C with a 50-g weight for 5 sec is not more than 65. It also has a higher softening point—85 to 96 C by the ring-and-ball method.

6. A tar pitch filler to conform to the following specifications:

	MINIMUM	MAXIMUM
Softening point, ring-and-ball method	45 C	50 C
Total bitumen content (soluble in CS_2)	70 per cent	....
Organic insoluble matter		20 per cent
Ash content	10 per cent	....

This particular filler gave a very satisfactory performance in one of the previous field studies.

7. A cement grout filler, a one to four mixture, by volume, of portland cement and grout sand. This sand is of such size that not less than 95 per cent passes a No. 16 sieve and not more than 10 per cent passes a No. 100 sieve. This mix was chosen because its coefficient of expansion closely approximates that of paving brick.



TEST PANEL WITH ASPHALT FROM BLENDED CRUDES
Heated to 125 F for 108 Hr; Exuding Practically Eliminated

8. A bituminized grout filler consisting of one part portland cement, two parts special asphalt emulsion, and three parts grout sand, by volume. This particular filler has sufficient plasticity to conform to the movement of the pavement with very little exuding.

9. A mastic filler consisting, by volume, of two parts Ohio highway asphalt filler and three parts special grout sand, of which 100 per cent passes a No. 30 sieve and 100 per cent is retained on a No. 100 sieve. The resulting mastic is practically non-exuding.

10. Two plastic sulfur fillers made by the reaction of sulfur with an agent, such as an organic sulfide, to render it plastic. The character of the resulting material depends on the kind and amount of the agent. Laboratory studies indicate that it is possible to produce plastic sulfurs which possess flexibility, waterproofness, extremely slight susceptibility to temperature variations, and a low coefficient of thermal expansion, approximating that of paving brick. One of the fillers to be used, designated Type A, represents the most inexpensive type of plastic sulfur suitable for a filler. The other, designated Type B, contains more of the plasticizing agent, is more expensive, and at the same time appears to be more desirable as a filler.

FEATURES TO BE DETERMINED

All the bituminous and plastic sulfur fillers are to be removed from the surface by the aid of any one of the

several agents now in common use for this purpose. It is hoped that the non-exuding character of the several fillers will display itself in actual use in the traveled pavement as it did in tests in the laboratory. If so, a decided step will have been taken in maintaining the original gritty surface of the brick.

Although the test is principally one of fillers, two other features of the investigation are of sufficient interest to warrant mention. A mastic cushion will be used, and all the base joint materials are to be of the pre-formed type, to extend through the full depth of the brick surface and base.

Grade Line for Resurfacing

By W. R. Flack, Assoc. M. Am. Soc. C.E.

Resident Engineer, Ohio Department of Highways, Medina, Ohio

In many cases the resurfacing of old pavements with bituminous concrete has been criticized because of the overruns in material used. Small deviations from a straight grade line do not affect the riding qualities of a highway and can save an appreciable volume of material. Establishment of the grade line to take advantage of irregularities in the profile of the old road requires some engineering expense but is very economical. I have used the method described here on several projects.

Three factors govern the preparation of a pavement for resurfacing: (1) building the old pavement up to the new standard crown; (2) filling depressions in the old surface in profile; and (3) accomplishing this smoothing with the minimum volume of new material. A base course of varying depth prepares the old pavement for the new surface to be applied at the uniform thickness required by the specifications.

The center line is established on the old pavement and points are set at 10-ft intervals. On concrete, this may be done by cutting small holes with a star drill, preferably one of $^1/_4$-in. diameter in a patent holder. In a bituminous pavement, short, heavy nails, such as hinge nails, may be driven. In either case, the points should be marked by small circles of white traffic paint. Levels are taken of these points and the work is checked until elevations accurate to 0.01 ft are obtained. These are plotted on a scale large enough for reading to the same accuracy so as to allow the small irregularities to be studied. A horizontal scale of 1 in. to 10 ft and a vertical scale of 1 in. to 0.5 ft has been used satisfactorily.

For the field work a wooden templet of the standard crown is made and on its upper edge a level is mounted. A 2 by 10-in. board is needed to make a templet for a crown of 20-ft width. The curve of the new crown is plotted on the board by an engineer, by measuring offsets from a tightly stretched thread. The cutting of the board to the curve is most neatly done on a band saw. A carpenter's level is too sluggish for accurately leveling the templet. A level vial of 90 sec precision costs about $2 and is well worth buying and mounting in a block to be bolted on the top of the templet. Thin wedges under the block permit adjustment by reversing the templet—a method like that used in correcting an engineer's level.

A party of four men is needed in using the templet, which is laid across the pavement with its center at one of the center-line points in the road. The templet is leveled, in which position it usually rests on only one place on the old surface. The lower edge of the templet represents the surface of the base course. Obviously, at the place where the templet rests, the thickness of the material is zero. This means shaping the old road to the curve of the new crown with the minimum volume of material. The standard crown is usually flatter than the original crown, and sometimes one edge of the old pavement has settled more or less uniformly and requires building up to bring both edges to the same elevation. The distance from the lower edge of the templet down to the old pavement at the center line is measured in hundredths of a foot and recorded. This little gap may be conveniently measured by sliding under the templet a wedge with graduations for thickness on its upper face. Two men carrying the templet, a third at the center directing the leveling and measuring the gap, and a fourth keeping notes can get the data at each 10-ft interval and move about a third of a mile an hour, depending on the traffic.

In the office the list of thicknesses of the base course at the center is used to plot, on the large-scale profile, points corresponding to the positions of the lower edge of the templet. As shown in Fig. 1, these points are joined by straight lines to form a temporary profile of the surface of the base course, after each cross section has been built up to the shape of the new crown, thus fulfilling the first condition. The third condition is met in that so little material is used that at each cross section at least one place on the old surface is bare. The old pavement is now reshaped on paper to the new crown at all points and with both edges of the roadway at the same elevation.

The large scale immediately shows that this would be a rough-riding, choppy profile. The distances scaled up from the old pavement differ so that the temporary profile apparently bears no definite relation to the existing pavement. The design is completed by filling up the low places in the temporary profile to form a smooth final profile. The large scale permits a rapid graphical solution of this part of the work. Triangles and railroad curves are used to lay out as smooth a line as possible, so as to require the addition of the minimum amount of new material. Exaggeration of the profile ensures that a smooth appearing line will produce a smooth riding highway. This step in the design deserves a most careful study. An experienced man will require about a day to establish a mile of final grade line.

From the profile the thicknesses of the base course at the center line at each 10-ft station are obtained by scaling from the profile of the old road to the final grade line. To this must be added the thickness of the new material, as shown on the typical section for the project. A list of these total fills is all the engineer needs in the field to establish the edge of the new pavement, working directly from the center-line points in the old pavement, both for elevation and alignment. Under some circumstances this list may be given to the contractor, and no stakes need be set. With intelligent form setters, this procedure works out very satisfactorily.

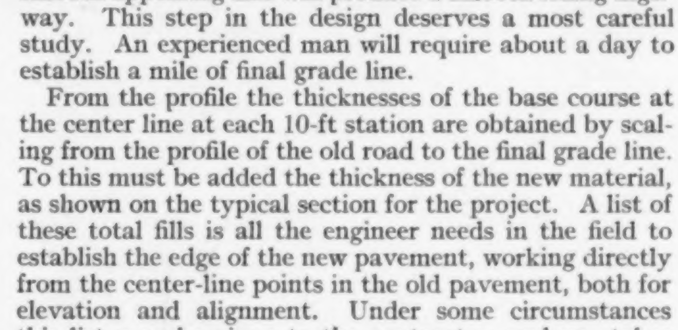


Fig. 1. Sample Profile with Grade Line for Resurfacing

In this way an old pavement can be built up to a new crown and given a smooth profile, with the minimum volume of material. In Ohio during the 1934 season if a grade line had been set without study and by visual inspection and had averaged only $^1/_4$ in. more material over the whole area than needed by this method, the increased cost would have been more than $800 per mile of 20-ft width.

Hoop Spacing on Wooden Tanks

By W. E. HOWLAND, ASSOC. M. AM. SOC. C.E.
ASSISTANT PROFESSOR OF CIVIL ENGINEERING, PURDUE UNIVERSITY, LAFAYETTE, IND.

IT is easy to obtain the required spacing for hoops at any point of known pressure or depth in a vertical, cylindrical tank constructed of wooden staves for a given diameter of tank and strength of hoop. However, when the top hoop is at the very top of the tank and the bottom one exactly at the bottom, it is a little more difficult to locate each hoop so that the spacing will be regular and at the same time conform to the requirements for strength. The methods here explained may serve to accomplish this result with a little more facility than is possible with the usual ones now employed.

It may be assumed that the top and bottom hoops each receive half the stress taken by each intermediate hoop, but that all intermediate hoops take the same stress. The total number of all the hoops will be one more than the total force on all divided by the allowable force on one. Suppose the hoops are to be designed merely to stand liquid pressure within the tank, which varies from zero at the top to a maximum of hw at the bottom, where h is the height of the tank and w is the unit weight of the liquid. The total horizontal force on the half section of the tank will then be h^2wr, where r is the radius of the tank. The number of required hoops, n, will be

$$n = \frac{h^2wr}{2f} + 1 \qquad [1]$$

where f is the allowable tension in the hoop, or $2f$ is the total horizontal force exerted on the half section by each hoop. A value of f will be selected or adjusted so that $\frac{h^2wr}{2f}$ will be a whole number.

A graphical solution is obtained by plotting the equilateral hyperbola, $x = \frac{f}{wry}$, and drawing the similar isosceles triangles, as shown in Fig. 1. The hoops should

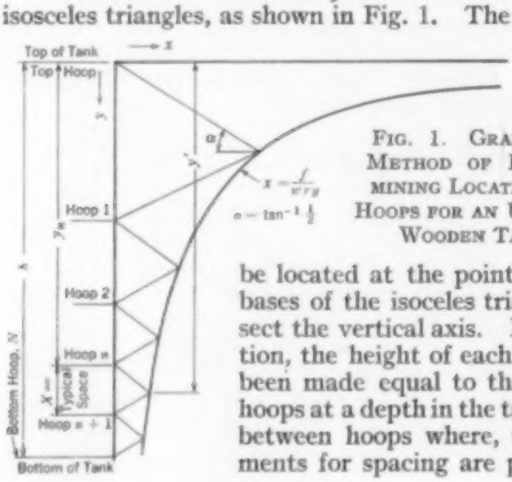


FIG. 1. GRAPHICAL METHOD OF DETERMINING LOCATION OF HOOPS FOR AN UPRIGHT WOODEN TANK

be located at the points where the bases of the isoceles triangles intersect the vertical axis. By construction, the height of each triangle has been made equal to the spacing of hoops at a depth in the tank half way between hoops where, the requirements for spacing are precisely the amount provided, that is, $\frac{f}{wry}$.

In an analytical solution the distance y from the top of the tank to any particular hoop is given by

$$y = \left(\frac{n}{N}\right)^{1/2} h \qquad [2]$$

in which N is the total number of hoops below the top one and n is the serial number of the particular hoop being located, counting the first hoop below the top, 1, the next one below, 2, and so on. The bottom hoop would of course be number N. This method is shorter than the graphical method previously described, but perhaps less easy to understand. It too is susceptible of a graphical application.

The soundness of this method may be shown best by finding the resulting space, X, between two adjacent hoops, say between hoops n and $(n + 1)$ in Fig. 1.

$$X = y_n - y_{n+1} = \left[\frac{(n+1)^{1/2} - n^{1/2}}{N^{1/2}}\right] h \qquad [3]$$

Here y is measured from the top of the tank, as before. Multiplying the left side of the equation by the average pressure at the center of the space $\left(\frac{y_n + y_{n+1}}{2}\right) w$, and the right by its equivalent $\left[\frac{(n+1)^{1/2} - n^{1/2}}{N^{1/2}}\right] h \times \frac{w}{2}$, it is found that space times average pressure is equal to

$$w\left[\frac{(n+1) - n}{N}\right] h^2 = \frac{h^2}{N} \times \frac{w}{2}$$

which is a constant for the entire tank. As already noted, $N = \frac{h^2wr}{2f}$ and if the average pressure is $y'w$, $X = \frac{f}{wry'}$. This checks the graphical solution.

These methods can be easily adapted to the case of a tank with a pressure on its top or to that in which each hoop takes an additional stress due to uniform compression between the staves. This latter condition might result from swelling of the wood or initial tightening of the bands. Here one may solve for the height, h', of a hypothetical open tank in which the liquid pressure at a distance above the bottom equal to the height, h, of the real tank would be equal to the known pressure at the top of the real tank, or equal in its effect on the hoop stresses to the known effect of compression between staves. Then one could apply the simple methods here described to this new hypothetical tank, of which the real tank would form merely the bottom part.

One modification is necessary in this case when the analytical method is used. On the real tank it is desirable that the highest hoop should occur exactly at the top, yet it is likely that the top actually will fall between hoops. When this happens it is recommended that the serial number, n', of the first hoop above the top of the real tank be determined and then a somewhat shorter hypothetical tank be calculated in accordance with the formula, $h' - \left(\frac{n'}{N}\right)^{1/2} h'$ for the height of the real tank, or

$$h' = \frac{h}{1 - \left(\frac{n'}{N}\right)^{1/2}}$$

in which N is the same as before.

When this slight change is made, it will be found that the equation, $y = \left(\frac{n}{N}\right)^{1/2} h$, applied to the new hypothetical tank, will locate all the hoops on the real tank.

OUR READERS SAY—

In Comment on Papers, Society Affairs, and Related Professional Interests

Method of Handling the Problem of Pole Embedment

Dear Sir: The article by Mr. Drucker on "Embedment of Poles, Sheeting, and Anchor Piles," in the December issue, is a worth while contribution to the subject. The problem of pole embedment, which comes up repeatedly, has been handled by the Pacific Gas and Electric Company in a somewhat different manner. The description which follows may be of interest.

In Fig. 1 is shown a pole embedded to a depth D below the ground surface. It is assumed that a horizontal movement of the pole will cause the wedge-shaped piece of material, TBD, to slide up the inclined plane, BD. It is assumed that BD is inclined 30 deg with the horizontal and that in plan the sides of the wedge flare out at 30 deg with the direction of pressure. It is further assumed that the angle of friction on the plane BD is 30 deg. Therefore $H = W$ ctn 30 deg, where H is the passive pressure on TB and W is the weight of the wedge. The passive pressure on any part of TB, such as AB, may be found by taking the difference in H for the two wedges TBD and TAK. In this manner the passive pressure for each foot of TB may be found.

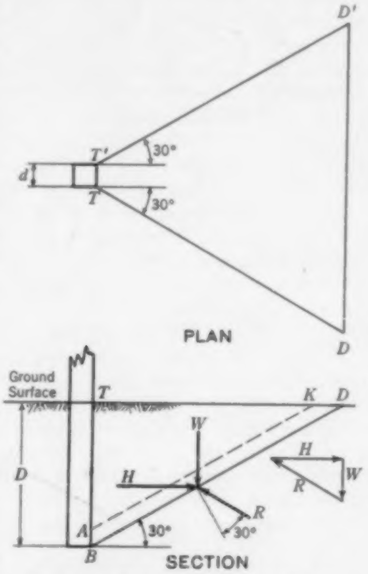


Fig 1. Embedment of Pole Below Ground Surface

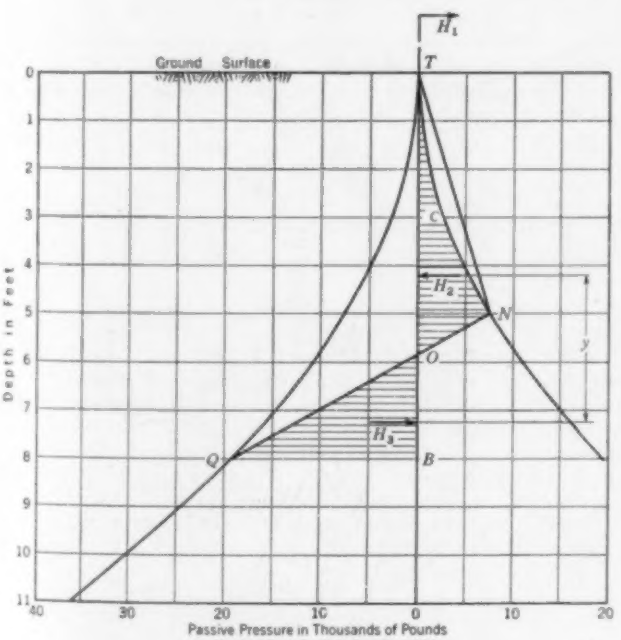


Fig. 2. Curve of Passive Pressures Plotted from Table I

Table I was constructed in this manner, using 100 lb per cu ft as the weight of the earth.

Table I. Passive Pressure in Pounds per Vertical Foot for a Pole 1 Ft Wide

Depth	Passive Pressure	Depth	Passive Pressure
1	250	7	14,600
2	1,120	8	19,200
3	2,650	9	24,200
4	4,750	10	30,000
5	7,450	11	36,200
6	10,800	12	43,200

As shown in Fig. 2, the curve of passive pressures, TQ, is plotted from the data given in Table I. In this figure TCN is the same curve repeated on the opposite side of the pole TB. The overturning moment caused by the external force H_1 is resisted by the forces H_2 and H_3, which are equal respectively to the areas $TCNO$ and OBQ. The center of rotation O is found by trial and is determined by the relation $H_1 + H_3 = H_2$. Since H_1 is usually small compared with H_2 and H_3, it is generally sufficiently accurate to let $H_2 = H_3$. If the additional approximation of using the triangle TNO instead of the area $TCNO$ is made, the process becomes the very simple one of finding the center of rotation O at such a location that the triangle TNO equals the triangle OBQ. The centers of gravity of the triangles are then found, and M equals H_2y. The curve in Fig. 3, which was constructed in this manner, gives the resisting moment of a pole 1 ft wide for various depths. It should be noted that, owing to the shape of the wedge of earth, the resisting moment will not be proportional to the width of the pole.

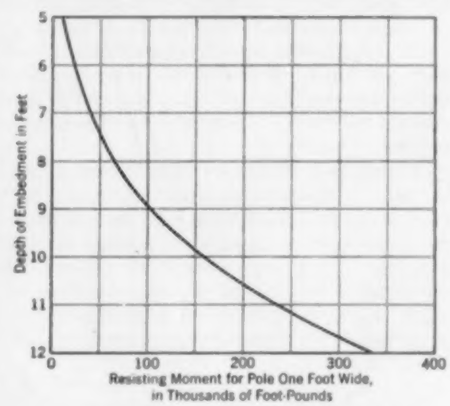


Fig. 3. Curve Showing Resisting Moment of Pole 1 Ft Wide for Various Depths

While this method is not perfect, it fairly well represents the forces stabilizing a pole for average soil conditions. With certain modifications, it has been used in the office of the Pacific Gas and Electric Company for the past 16 years with no unsatisfactory results.

The method described by Mr. Drucker assumes that the passive pressure will increase directly as the depth, with the result that the resisting moment varies as d^3. Our method assumes an increase in the passive pressure at a greater rate than a direct ratio due to the flaring shape assumed for the wedge, and results in a resisting moment which varies nearly as d^4. It seems reasonable that the passive pressure on a pole should increase at a rate greater than a direct ratio with the depth. A direct variation in the ratio of passive pressure will be approached as the pole is widened (as in the case of sheet piling) and the flare of the wedge becomes less important.

C. W. Appleford, Assoc. M. Am. Soc. C.E.
Assistant Engineer, Pacific Gas and Electric Company

San Francisco, Calif.
April 7, 1935

Distribution of Federal Maps

TO THE EDITOR: The article on "State Surveying and Mapping Bureaus" by Professor Dodds, in the April issue, is particularly timely in view of the fact that there will be much new material in this field as a result of the greater number of maps now being produced by Federal agencies. These maps will have much wider use than can at present be foreseen and should be procurable through many sources. In the field of air transport alone accurate land charts, based on contour maps, are indispensable. Apart from the need for maps for technical purposes, the public now has increased leisure for such diversions as motoring, hiking, and other outdoor activities that necessitate the use of maps. The popular demand for such maps in Europe is enormous, with the result that there are governmental agencies engaged in preparing topographic sheets for use by hiker, hunter, fisherman, camper, and the devotee of winter sports. Distribution agencies advertise their stock so well that almost every motorist and sportsman has his pockets bulging with maps of the territory he proposes to cover.

Under the present administration a new impetus has been given to state and Federal planning, and those engaged in this field know that the basis for such work is accurate topographic maps. Planning entails a knowledge of highways, land classification and use, parks and parkways, water and mineral resources, forests, rivers and harbors, flood control, ground-water supplies, sanitary investigations, public water supplies, and pipe and power lines. In these and other engineering fields a great deal of time and expense may be saved through the use of standard topographic sheets.

In addition to state bureaus, there should be in each county seat all the data relating to that county so that local engineers can procure them quickly without sending to the state capital, or going there. It should be the duty of the state agency to keep the county offices supplied immediately with all new information.

Furthermore, now that the U. S. Coast and Geodetic Survey is establishing control points in each municipality, the data covering these should be available at municipal headquarters, preferably in the city engineer's office. All surveys should be tied in to these control points, and a copy of the plan should be filed in the city engineer's office.

The present notices of Government maps ready for distribution are sent on cards about 5 by 6 in. in size, and the current information on the subject of maps is printed on these cards in type so small as to necessitate the use of a magnifying glass for comfortable reading. Thus it is obvious that Government methods of map distribution are in need of a radical change. Professor Dodds has made a distinct contribution in the direction of facilitating the distribution of technical map material in this country.

HENRY J. SHERMAN, M. Am. Soc. C.E.
Consulting Engineer

Camden, N.J.
April 9, 1935

Tabulation of Costs

TO THE EDITOR: During the summer of 1882, while in the service of the Morse Bridge Company, of Youngstown, Ohio, I was detailed to complete shop plans for a 1,573-ft tunnel under the South Side Rolling Mill of Jones and Laughlin Limited, of Pittsburgh, Pa. (now the Jones and Laughlin Steel Company), for an extension of the Pittsburgh and Lake Erie Railroad along the Monongahela River.

The plan finally decided upon called for vertical sides decked over with 30-in. plate girders set side by side. The bridge company contracted to furnish these girders. This rush order constituted a nice contract for those days and promised a good profit. Up to that time, the cost price of wrought iron bridges was so much a pound for pin-connected spans, with 10 per cent off for the duplicate spans, and 15 per cent off for three or more duplicate spans.

The work was completed on time but the books, strangely enough, showed a decided loss. Just about then a bridge inspector of the Mahoning Division of the Erie Railroad by the name of Gustav Lindenthal (now Hon. M. Am. Soc. C.E.) arrived from Cleveland, Ohio, with a set of instructions or specifications for railroad bridge inspection, which he had blocked out, that horrified the office force. Such a thing as written specifications had never been thought of. Lindenthal had been considered a nuisance for he had even insisted on having some physical tests made in the shops, and now his following them up with written requirements was considered such a reflection on the integrity of the office and shop that the matter was taken up with the chief engineer who, to our horror, approved the specifications.

The loss on the girders and the incident of Lindenthal's specifications convinced my brothers—Henry G. and C. J. Morse—that the cost of all classes of work going through the office and shops should be known, since we had either to be annoyed by inspectors or else go out of business. I had spent three years as laborer and machinist in all parts of the shop and was therefore ordered to make a detailed tabulation of every item in every contract for construction.

After approved forms for the different departments for the division of time of labor in the office, yard, and shops were printed, they were distributed to the men who absolutely refused to be annoyed with such nonsense. Furthermore, most of them didn't have watches; during their 10-hr day they went by the morning, noon, and night whistles. The situation resulted in a strike, and some of the most skilled laborers threw up their jobs. However, personal interviews were held with many of the men who knew me as one of them, and each item of construction was tabulated and then taken to the different heads of departments, so that they could see the value of the system. The men then became interested and entered into a contest to see if the costs couldn't be reduced.

After six months of heart-breaking experiences the work of uniform cost tabulation was going so smoothly that it was possible to classify the costs of different types of work as they passed through the office, yard, and rivet machine, and blacksmith shops. There were many surprises. For instance, it was found that the cost of the tools and blacksmith work was double the estimated cost.

So far as we knew, the tabulation of bridge, shop, building, and other costs had never been intelligently established prior to the tabulation made by our company in 1882. These data gave a chart that showed at a glance what designs were excessive in cost and why. During the year 1883 the erection costs were tabulated according to the same method that had been followed for the construction costs. The practice was continued, so that today accidents and losses in erection are greatly reduced.

EDWIN K. MORSE, M. Am. Soc. C.E.
Water and Power Resources Board of Pennsylvania

Pittsburgh, Pa.
March 27, 1935

Simplicity in Concrete Design

TO THE EDITOR: Every designer who deals with the proportioning of beams or columns will find Mr. Mitchell's article in the October 1934 issue very useful, especially in cases where bending plus direct stress occurs, such as in frames. Since the original article was published, Mr. Mitchell has improved his own work by replacing the expression for

$$\frac{6nNe_1}{f_s bd^2} \text{ by } \frac{6Ne_1}{f_c bd^2}$$

which results in greater simplicity of diagrams and application.

A development of his equations and tabulated values of $\frac{6Ne_1}{f_c bd^2}$, k, and j, based on values of $\frac{f_s}{nf_c}$ from 1.88 to 10.0, is to be found in *Structural Frameworks*, by Thomas F. Hickerson, published by the University of North Carolina Press, Chapel Hill, N.C.

Also, Mr. Mitchell has developed a very comprehensive diagram to include T-beams in bending or bending plus direct stress. The same diagram applies to either rectangular beams or T-beams and covers any values of n, f_s, and f_c. This diagram has been used by designers in this office for the past three months, and it is certain that from the standpoint of directness and simplicity the method is superior to any other known to us.

G. T. PARKIN, Jun. Am. Soc. C.E.
Designer, State Highway and Public Works Commission

Raleigh, N.C.
March 15, 1935

Highway Grades Over Crests Determined by Chart

DEAR SIR: The article in the March 1935 issue, "Increasing the Safety of Highways—Design Principles and Travel Speeds," by Mr. Lawton, is of considerable interest to me because of certain work along this line done some eight years ago in connection with the laying of grades on roads constructed by the State Highway Department in Oakland County, Michigan. In the design of two- or three-lane roads it was recognized that a material factor in traffic safety was the length of sight afforded to drivers. As the width of right-of-way usually acquired for these roads was materially greater than the width of the pavement, and as the limit of horizontal curvature was usually small, the problem became mainly one of vertical curvature over crests or at sharp breaks in grade. It was apparent that the length of sight varied inversely as a function of the algebraic difference in grades on either side of any crest or break. For the purpose of accelerating the operation of determining the length of sight afforded by any given set of conditions, it was decided to prepare a graphic chart based on certain assumptions. These assumptions coincided fairly well with those in Mr. Lawton's article.

Before this work was started, search was made in engineering literature to see if it afforded the desired data. The only material found was a short table in Harger and Bonney which gave sight distances up to some 400 or 500 ft. As the ideal was considerably in excess of this, it was decided to make a chart, Fig. 1, suitable to the needs of more modern high-speed traffic.

The use of Fig. 1 may be illustrated by the following examples. Assuming an algebraic difference in percentage of grade of 8 per cent and a required length of sight over the crest of 600 ft, the ordinate for 8 per cent is followed to its intersection with the curve for a 600-ft sight distance. This point of intersection reads 720 ft on the *y* axis, showing that a length of parabolic curve of 720 ft is necessary. The point of intersection also shows a vertex correction of approximately 7.2 ft which is the distance down from the intersection of the two grade tangents to the midpoint of the vertical curve.

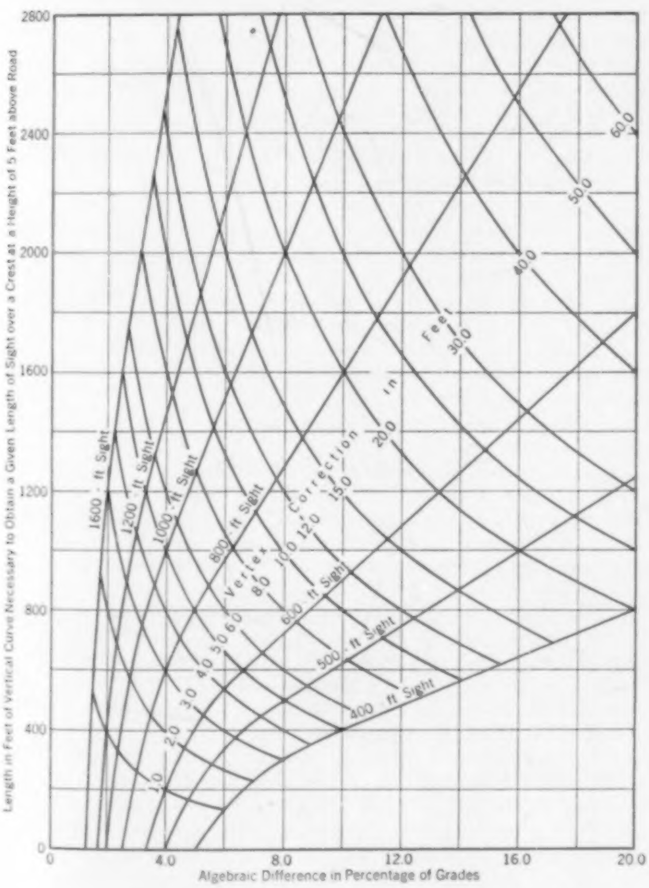


FIG. 1. GRAPHIC CHART USED IN LAYING HIGHWAY GRADES

Relation Between Parabolic Vertical Curves, Vertex Corrections, and Lengths of Sight Afforded by Such Curves Over Crests at a Height of 5 Ft Above the Road

As another example, assume an algebraic difference in percentage of grade of 4 per cent and a maximum permissible length of vertical curve of 600 ft. The problem is to determine what length of sight is afforded over the crest and what is the vertex correction. To answer these questions, follow up the ordinate of 4 per cent difference in grade to its intersection with the abscissa through the 600-ft length of curve. These two lines intersect on the 800-ft sight curve and also on the 3-ft vertex correction. It will be noted that in all cases where the length of sight exceeds the length of the curve, the curves are straight lines.

Although this chart has been copyrighted, the copyright is dedicated to the use of the public, and I will endeavor to supply a limited number of prints without cost.

H. H. CORSON, M. Am. Soc. C.E.
City Engineer

Birmingham, Mich.
March 23, 1935

Separation of Highway Grades

TO THE EDITOR: The article on "Separation of Ways" by Mr. Ford, in the March issue, principally concerns the separation of railway and highway grades. Although I am fully in agreement with him that this work is a necessity and that the public—whether represented by Federal, state, or municipal authority, or a combination of all—should bear the major cost, I still feel that there is greater need for the separation of highway grades, including streets.

A train is controlled in its route by the track, and it is operated by trained men. An automobile, on the other hand, is controlled in its route only by the driver, and it is often operated by persons who give little heed to the possibilities of danger at crossings of any character. Their sole concern is speed, and they are regardless of the consequences. Then, again, the intersection of two heavily traveled streets presents more possibilities of accidents than do railroad grade crossings, because the number of train movements in a day is small, as compared with the number of automobiles in use.

Within sight of my office there is a street crossing where a recent traffic count showed 40,000 vehicles passing in 10 hr. It is protected by a system of signals supposed to be foolproof, but hardly a day passes without at least one collision. Thus, from the viewpoint of protection to transportation, the separation of such grade crossings is more imperative than the separation of railroad crossings. It is obvious that many highway grade crossings can never be separated, but this does not mean that intersections should not be eliminated when possible.

In October 1933, a report was published under the title *A Limited Way Plan for the Greater Chicago Traffic Area*. This report, which constitutes a valuable contribution to the problem of separation of ways, outlines plans for the construction of elevated structures that can be used in many localities. Cities like St. Louis, where the topography is of a broken or undulating character, present many opportunities for the direct grade separation of street crossings and, under existing conditions, the problem is more financial than engineering.

In his statement that, "Within recent years, we have been catapulted into an age of mechanical transportation," Mr. Ford presents a reason for the magnitude of the grade separation problem. The construction of automobiles by the millions caused a demand for immediate highway construction, and it was to be expected that the men entrusted with this work would make mistakes, especially since they were under pressure. As in railroad location, future developments could not be foreseen.

In the words of the late President Cleveland, "We have a condition and not a theory confronting us." Coordination of planning is the first step toward bringing order out of chaos.

BAXTER L. BROWN, M. Am. Soc. C.E.
President, Board of Public Service of St. Louis

St. Louis, Mo.
April 4, 1935

Need for Traffic Engineers

TO THE EDITOR: In his article in the April issue Mr. Williams correctly states that there will be no less need for the profession of traffic engineer in the future than there is today. Considering the billions of dollars that are spent annually in constructing and maintaining a system of rural highways and city streets, it seems ridiculous not to use a trained personnel to operate this system. The National Safety Council urges the need of a trained full-time traffic engineer with a regularly organized traffic engineering department in each city of over 250,000. This is a very conservative estimate, and I feel that it could well be lowered to include cities with a population of 100,000.

There are some 40 cities in the United States with populations over 250,000. In the whole country, however, there are only 25 men on full-time work in traffic engineering and about 50 men on part-time work. Thus it seems that the need for trained traffic engineers is not very well recognized. I agree heartily with Mr. Williams' statement that in practically every city or town a traffic engineering set-up of some sort is needed. In fact, faulty traffic operation and control often cause greater economic and social loss in small communities than in those of greater population, because of the lack of parallel streets, the less efficient traffic-enforcing bodies, and the lack of civic effort to educate vehicle drivers and pedestrians.

The future of traffic engineering involves a program of education. First, city and state officials as well as the general public must be educated in the need for a traffic department with a trained personnel, and then engineers must be educated to fill such positions. I agree with Mr. Williams that city engineers, highway engineers, or city and regional planning engineers can do traffic engineering work, but they will have to devote the necessary time and study to it. Present traffic problems are very complicated, and it will be necessary to have a full understanding of the facts in determining the best possible solution for any given problem.

I hope that the field of traffic engineering will be made sufficiently attractive to draw capable men from other fields. Many universities are now giving excellent courses of study in traffic engineering, but the seeming lack of enthusiasm on the part of public officials for trained traffic engineers has kept down the enrolment.

When the Institute of Traffic Engineers was founded several years ago practically all the charter members were also members of the Society, and of the 87 corporate members making up the institute today, 24 are also corporate members of the Society. As Mr. Williams points out, the traffic engineer becomes interested in a new project at its very inception. Thus his co-workers are engineers and, in the main, civil engineers. I feel therefore that a much closer bond should be maintained between the institute and the Society. Such an association would be mutually advantageous and would benefit everyone interested in the control of traffic on streets and highways.

WARREN E. DE YOUNG, Assoc. M. Am. Soc. C.E.
District Manager, Automatic Signal Corporation

Chicago, Ill.
April 5, 1935

Encroachment of Marine Borers

TO THE EDITOR: As indicated in the abstract of the committee report on marine borers on the New England coast, Mr. Shepard and the committee, with the assistance of Dr. William F. Clapp, have obtained information of great value to all who are interested in structures in salt water. There is no question but that there has been a great increase in the intensity of attack in New England as a whole, and present information indicates the probability that the same is true in parts at least of the Chesapeake Bay area. Borers are appearing where there has been no previous evidence of them.

Ten years ago no marine life was evident in Newark Bay, but since that time the effect of the opening of the Passaic Valley sewer has resulted in a reduction of pollution. During the past season barnacles and hydroids were found as far up as the Hackensack and Passaic rivers, and teredine borers have been reported. This report has so far not been confirmed but the presence of these encrusting organisms indicates that borers could exist.

LEFT: LOW-WATER BRACES OF UNTREATED PINE ATTACKED BY TEREDO AND LIMNORIA, STAPLETON, STATEN ISLAND, N.Y. (MARCH 1935). RIGHT: UNTREATED OAK FENDER PILE AT BAYONNE, N.J., SHOWING BARNACLES ON SURFACE. LIVE TEREDO WERE FOUND (OCTOBER 1934)

Dr. Clapp's studies are making it possible to connect the presence of certain encrusting organisms with the existence of borers. If further study confirms conclusions already drawn, valuable information will be available for the engineering profession. A competent biologist will be able to tell by inspection of encrusting organisms whether the presence of borers is probable. In the past too little attention has been paid by engineers to the studies of biologists. As is demonstrated in New England, it is never safe to assume that because there is no attack at a given time there never will be. Very little is known of the water conditions that encourage or inhibit these attacks. The low limit of salinity for one species of teredo is known, and although there are seemingly reasonable theories as to requirements of temperature, dissolved oxygen, hydrogen ion, and similar factors, they are not demonstrated facts with regard to any given species of borer. Much biological research is needed.

In the face of these conditions those responsible for the construction of waterfront structures should, for the protection of their clients, proceed as follows:

1. Inform themselves as to whether borers are present near any untreated structures and, if so, have divers make an inspection. If not, consult a competent biologist as to whether encrusting organisms indicate the possibility of attack.
2. With the advice of biologists watch any change in organisms that may indicate favorable conditions for borers.
3. Build all new structures and do all heavy maintenance work with creosoted timber, unless the salinity of the water is known to be too low for serious attack.
4. Obtain good treatment by patronizing reputable companies and use enough creosote.

Because of lack of previous experience many renewals in the newly attacked area in New England have been made with untreated timber, and when treatment was used it was too light. The U. S. Government minimum is 16 lb of creosote per cu ft of wood, and the American Railway Engineering Association recommended minimum for pine is 22 lb. The use of a 22-lb instead of a 12-lb treatment of timber would make the increased cost of the average pile in place in Boston less than 4 per cent, although a vastly greater amount of protection would be obtained.

Many engineers not accustomed to the use of treated timber waste considerable money by specifying the same kind of timber for treatment that they have been using untreated, when a lower grade and a cheaper timber would give better results because it would take treatment better. The different species of pine do not differ in strength, if the density and knot structure are the same. The less heart wood present the better. For this reason, there is no excuse for specifying "long leaf pine" for treatment, since it costs more than the other species. It is difficult to treat red oak and almost impossible to treat white oak.

WILLIAM G. ATWOOD, M. Am. Soc. C.E.
Consulting Engineer

New York, N.Y.
April 2, 1935

SOCIETY AFFAIRS

Official and Semi-Official

Plans Progressing for Sixty-Fifth Annual Convention

To Be Held in Los Angeles, July 3, 4, and 5

Plans for the Sixty-Fifth Annual Convention of the Society to be held in Los Angeles, Calif., July 3 to 5, 1935, briefly announced in the April number of Civil Engineering, are now approaching completion. In addition to a technical program of broad general interest to engineers throughout the country, the local committee in Los Angeles is planning a program of entertainment in keeping with California hospitality. From among all the varied activities of this metropolitan region the utmost of engineering and social value is being selected for the attention of members and guests.

Convention headquarters will be maintained in the Ambassador Hotel and there many of the out-of-town visitors will be accommodated. This noted hostelry is amply capable of taking care of such a gathering. Located a few miles west of the center of the city, it is in somewhat of a country club atmosphere and hence provides greater quiet for the many activities of the Convention. It is convenient at the same time from both Los Angeles itself and Hollywood and Beverly Hills on the west.

Preceding the opening of the Convention on Wednesday morning, July 3, the Breakfast Club will be host to the party. This is a unique organization, whose meetings at the early morning meal are broadcast by radio. Its invitations to visiting guests are highly prized, and thus the Society is signally honored. Immediately following, the Convention will be officially opened. Various addresses and responses will be made, including the address of welcome, the annual address of the President of the Society, and a talk on Spanish land grants and old missions.

Following lunch, that same afternoon, there will be a general meeting on the subject of the development and future of Southern California, particular attention being given to the Los Angeles basin, its growth and improvement, and the projects that will be necessary to care for future population.

Technical Sessions and Social Events

As usual, the second day of the Convention, Thursday, July 4, will be set aside for the sessions of the Technical Divisions. The number of Divisions that are arranging programs is an excellent indication of the interest aroused. Among the Division sessions scheduled are those on Construction, Highways, Irrigation, Power, Sanitary Engineering, Waterways, and City Planning. Complete details of the main meeting program and the Division sessions will appear in the June number of Civil Engineering.

Unusually interesting social events are promised. The entertainments arranged by the local committee include a dinner dance on Wednesday evening, July 3, at the hotel, and a variety of drives and teas for the ladies. Among these outings is one leaving the hotel Wednesday morning for an automobile trip through Pasadena and the orange belt to Padua Hills Theater north of Claremont, to be followed by lunch. Similarly, on Thursday afternoon the ladies will enjoy a drive through Beverly Hills and Belair, with afternoon tea in the gardens of Mrs. John D. Frederick.

Two separate events are planned for Thursday evening. The ladies are to have dinner in Hollywood followed by a theater party at the Chinese Theater. Meanwhile, the men will be occupied in the afternoon, following the Division meetings, with a golf tournament, and immediately afterward will enjoy a smoker at one of the nearby country clubs. Friday will be entirely devoted to an excursion through motion picture studios, a treat for the out-of-town visitors particularly.

Scheduled for Saturday, July 6, is an all-day trip to Santa Catalina Island, one of the beauty spots of Southern California. Reaching Los Angeles harbor by interurban electric tram, the party will then embark on the steamer. In addition to the ocean trip, this excursion offers an opportunity for studying marine life through the famous glass-bottomed boats at Santa Catalina.

Among the additional trips which will without question appeal to all is a visit to San Diego and its California Pacific International Exposition, which will then be in progress in Balboa Park. Sunday, July 7, is suggested for this trip, and to celebrate the event the Exposition is expected to designate this "American Society of Civil Engineers Day," with the Local Section there as hosts. Situated over a hundred miles south of Los Angeles, San Diego is noted for its beauty. It is comparatively near the international border and within a few miles of Agua Caliente, a noted pleasure resort in Mexico.

Convention Tour from the East and Middle West

Of particular interest to members residing in the East and Middle West is the plan for an all-expense tour to Los Angeles, the party concentrating at Chicago. There will be stop-overs at Colorado Springs and Denver, also a day at Salt Lake City. Then follow three days or more enjoying the wonderful National Parks in Southern Utah, including Zion, Bryce Canyon and Cedar Breaks. One whole day will be devoted to an inspection of Boulder Dam. To many this will provide an opportunity of seeing this monument of engineering progress under construction. From Denver the route will pass through the famous Moffat Tunnel and the new Dotsero cut-off. The party will arrive in Los Angeles on Sunday morning, June 30.

Complete details regarding the points of interest on the itinerary, the cost of various return routings, and other matters, may be obtained directly by writing to the Secretary of the Society. The official program of the Convention, to be included in the June issue of Civil Engineering, will give a multitude of further details on what promises to be a most notable Society gathering.

Denver and Rio Grande Western RR.

Along the Dotsero Cut-Off, Following Colorado River
Route of the Special Convention Trip to Los Angeles

Union Pacific RR.

Cedar Breaks, Utah, a Vast Amphitheater
Party on Society Trip Will Visit This Beauty Spot

Recommendations for Determining Fees to Be Allowed for Professional Engineering Services

On Federal and Federal-Aid Projects Undertaken as an Aid to Industrial Recovery or to Relieve Unemployment

REPORT OF THE SOCIETY'S COMMITTEE ON FEES

FOREWORD

THE following data and recommendations on fees for professional engineering services have been prepared for use upon Federal or Federal-aid projects initiated primarily to afford aid to business recovery and relief of unemployment.

The fees recommended are designed to reimburse the engineer for out-of-pocket expense and a moderate overhead expense, and to afford modest compensation to the engineer for his own time and services. The tabulated fees (Table I and Fig. 1) and the comments thereon are founded on the principles set forth in the Manual of Engineering Practice No. 5, adopted by the American Society of Civil Engineers on July 7, 1930.

It is contemplated that each engagement will be based upon a contract negotiated at the outset which shall specify which curve for engineering fees is applicable to the problem at hand, or, where neither of the curves applies, shall stipulate the percentage, or per diem fee, to be paid. Statements are presented which are intended to specify exactly what payments, if any, shall be made in addition to the percentage fee, and how such additional payments shall be computed.

Engineering service on a contingent basis is frowned upon. The tabulated fees (Table I and Fig. 1) are not adequate to afford compensation for contingent service.

In addition to reliance upon the principles set forth in Manual No. 5, the data presented are intended to reflect the experience of about thirty engineers whose home offices are situated in various parts of the country, and practically all of whom have established businesses which have been conducted for a period of one or more decades.

FEES FOR ENGINEERING SERVICES

A reasonable fee for engineering services should vary with:

1. The cost of the project
2. The complication of the project
3. The extent of engineering services to be furnished by the engineer
4. The experience and record of the engineering organization

The costs of some items of the engineer's services can be estimated with a moderate degree of certainty; the costs of other items are beyond his control and cannot be estimated closely. Two curves are presented herewith (Fig. 1) for use in estimating a reasonable percentage fee for that portion of the engineering work for which the cost can be determined closely and in advance. These curves are intended to apply to GENERAL WORK. Higher fees than those indicated by the curves are justified by unusually difficult or complicated projects. Lower fees than those indicated by the curves may be considered appropriate for simple projects which involve simple elements or large duplication of parts.

Curve *A* is intended to apply to highly mechanized or highly complicated projects, such as: power plants, pumping stations, incinerators, water and sewage treatment plants, complicated bridges, complicated grade-crossing eliminations, and complicated dams, and air-pressure tunnels.

Curve *B* is intended to cover general engineering services and to apply to such projects as: municipal improvements, sewers, storm drains, water-distribution systems, simple bridges, simple grade-crossing eliminations, simple dams, irrigation works, railways, highways, river and harbor improvements, sewer and water tunnels (free air), and wharves, piers, and docks.

Work Covered by Fee Taken from Curves. In general, the percentage fee taken from the curves (Fig. 1) should cover such of the following items as may be required: preliminary investigations, assistance in application for Federal funds; preparation of designs, plans, and specifications; estimate of quantities and costs; assistance in securing bids; analysis of bids; assistance in letting contracts; checking shop and working drawings furnished by contractors; consultation and advice during construction; reviewing estimates for progress and final payments to contractors; and final inspection and report.

Items to Be Paid for in Addition to Percentage Fee. The following items of cost cannot be determined accurately in advance and are not within the sole control of the engineer. They should be paid for in addition to the percentage fee in the manner stated, and the engineer should keep separate complete accounts of these fixed items:

1. Field surveys for preliminary investigations—to be paid for by reimbursement of actual out-of-pocket expense plus 25 per cent for overhead.
2. Field surveys for design—to be paid for by reimbursement of actual out-of-pocket expense plus 25 per cent for overhead.
3. Services of resident engineer—to be paid for by reimbursement of actual out-of-pocket expense plus 25 per cent for overhead.
4. Services of field staff additional to services of resident engineer—to be paid for by reimbursement of actual out-of-pocket expense plus 25 per cent for overhead.
5. Furnishing reproduction of drawings or plans and specifications—to be paid for by reimbursement of actual out-of-pocket expense.

Day-Labor Projects. Where advisory services in the management of day-labor projects is undertaken, the work required of the engineer is increased and his fee should be increased by a sum equal to at least 1 per cent of the estimated cost of the project.

Special Tests. The client should pay directly, and in addition to the percentage fee, for special tests and research, mill and shop inspection of materials and equipment, and for foundation explorations such as borings, test pits, and soil mechanics laboratory investigations.

Alternate Designs. When competitive bids are taken for construction on alternate designs, where this involves the preparation of designs, plans, and specifications for alternate structures, the compensation to the engineer should be based on the percentage of the actual cost of the work built, plus one-half the same percentage of the bid cost (or estimated cost if no bid) of the alternate designs prepared.

TABLE I. ENGINEERING FEES FOR SPECIAL SERVICES IN CONJUNCTION WITH ARCHITECTS

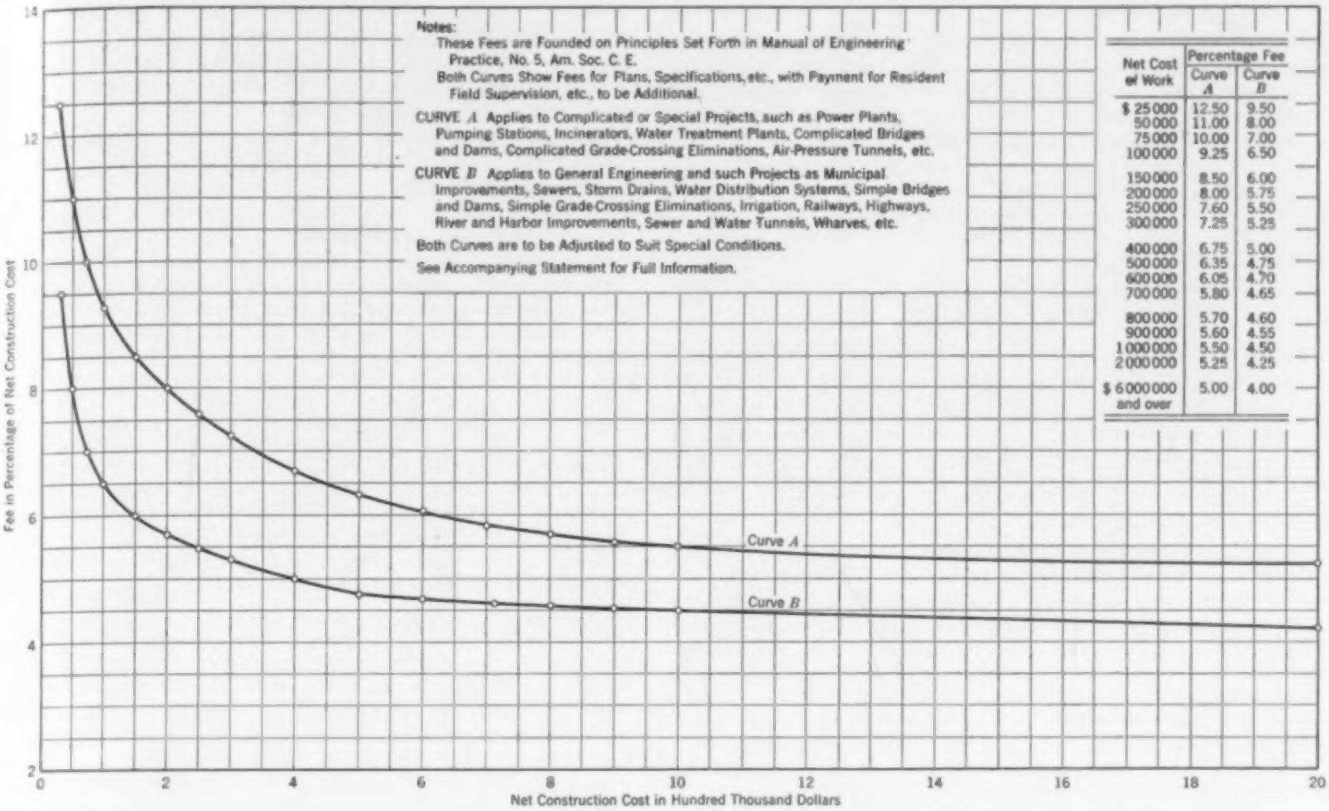
Tabular Values Are Percentages to Be Applied to the Actual Cost of That Portion of the Project Upon Which the Engineers' Services Are Rendered

These Fees Are for Use When an Architect Handles the Principal Design But an Engineer Is Engaged to Provide the Specific Services Listed

Type of Services	Actual Cost of Work Designed by the Engineer (Not Including Cost of Engineering and Architecture)					
	$50,000 or less	$50,000 to $100,000	$100,000 to $250,000	$250,000 to $500,000	$500,000 to $1,000,000	$1,000,000 and More
Foundation engineering . . .	7 1/2%	6%	5%	4%	3 1/2%	3%
Structural engineering*† . . .	6%	5%	4 1/2%	3 3/4%	3 1/4%	2 3/4%
Equipment: mechanical, electrical, elevators, heating, ventilating, plumbing . . .	6%	5%	4 3/4%	4 1/2%	4 1/2%	4 1/4%

* For apartment houses and armories increase the fees by 1/4 per cent.

† In cases where complete structural design is required to resist lateral forces, as in California (the so-called earthquake law), these fees shall be increased appropriately.



Net Cost of Work	Percentage Fee Curve *A*	Percentage Fee Curve *B*
$ 25000	12.50	9.50
50000	11.00	8.00
75000	10.00	7.00
100000	9.25	6.50
150000	8.50	6.00
200000	8.00	5.75
250000	7.60	5.50
300000	7.25	5.25
400000	6.75	5.00
500000	6.35	4.75
600000	6.05	4.70
700000	5.80	4.65
800000	5.70	4.60
900000	5.60	4.55
1000000	5.50	4.50
2000000	5.25	4.25
$ 6000000 and over	5.00	4.00

FIG. 1. FEES RECOMMENDED FOR PROFESSIONAL ENGINEERING SERVICES ON FEDERAL AND FEDERAL-AID PROJECTS
Expressed in Both Graphic and Tabular Form

Redesign Required by Owner After Study Designs Have Been Accepted. When redesign of works is required by the owner after the study designs have been accepted, the engineer shall be compensated for such redesign at actual out-of-pocket expense and allowance for principals' time, plus 25 per cent for overhead.

Consulting Services. Where consulting, specialist, or expert services are rendered, the engineer should be compensated upon a per diem basis for all time devoted to the work, including time of travel. For such services the fee should be from $50 to $100 per day, or more, according to the breadth of experience of the engineer. In all such cases, he should be reimbursed for travel and subsistence expense while away from his home office, in addition to the payment of the fees stated.

Litigation. Contracts for engineering services should include a clause to the effect that nothing in the contract shall be construed to obligate the engineer to prepare for or appear in litigation in behalf of the client, except in consideration of additional compensation.

Losses. Contracts should include a clause to the effect that in any event the payment to the engineer shall not be less than his actual out-of-pocket expense, excluding the time of principals.

Work in Conjunction with Architects. In cases where an architect is engaged to design a building, and an engineer is engaged to handle the problems of foundation and structural engineering and of mechanical, electrical, and sanitary equipment, the engineer should be compensated in accordance with the attached tabulation (Table I) in which fees are given for these special services. The fees for such services are in addition to the architect's fee.

This service includes designs, drawings, and specifications, and advisory supervision of construction.

This class of work includes such projects as: city halls, comfort stations, fire stations, homes for aged, hospitals, municipal auditoriums, and school houses.

Committee on Fees
ENOCH R. NEEDLES, *Chairman*
Walter W. Colpitts
D. B. Steinman
J. Vipond Davies
J. F. Sanborn, *Contact Member*

New York, N.Y.
March 26, 1935

Approved and ordered printed by the Board of Direction, American Society of Civil Engineers, April 3, 1935

Meeting of Board of Direction, April 3 and 4, 1935—Secretary's Abstract

ON APRIL 3 and 4, 1935, the Board of Direction met at the Miami Biltmore Hotel at Coral Gables, Miami, Fla., with President Arthur S. Tuttle in the chair. Those present were George T. Seabury, Secretary; Otis E. Hovey, Treasurer; and Messrs. Barbour, Burdick, Crawford, Dewell, Eddy, Etcheverry, Hammond, Hogan, Horner, Leisen, Morse, Noyes, Poole, Riggs, Sanborn, Sherman, Stabler, Trout, and Wilkerson.

Approval of Minutes

The minutes of the meetings of the Board of Direction held on January 14–15, and January 17, 1935, were approved.

The minutes of the meeting of the Executive Committee held earlier in the day, on April 3, 1935, were also approved and the actions outlined therein were adopted as the actions of the Board with the exception of certain items which were considered and acted upon separately.

Defense of Members: Method of Procedure

Careful consideration was given the method of procedure, recommended for approval by the Executive Committee, to be followed in connection with the defense of members accused and condemned, or deprived of position, without hearing. The procedure, approved by the Board, is featured elsewhere in this issue.

Instances involving two members who had thus suffered were presented, and after full consideration the Board instructed that the matter be followed up by the Secretary in an attempt to remedy the injustice. A general description of this situation also appears elsewhere in this issue.

Committee Reports to Board

Reports were received from the Society's Committee on Publications; the Committee on Professional Conduct, which had under consideration three instances of alleged unethical conduct; the Committee on Accredited Schools; the Committee on Research; and the Committee on Student Chapters. Progress reports were received from the Committee on Honorary Membership, the Committee on Districts and Zones, the Committee on Professional Activities, the Committee on Technical Procedure, the Committee on Relations of the Federal Relief Agencies to Civil Engineers, the Committee on Juniors, the Committee on Engineering Education, the Committee on Public Education, and the Committee on Registration of Engineers.

Mississippi State College Reinstated as "Accredited School"

In accordance with the recommendation of Committee on the Accredited Schools, the Mississippi State College was reinstated as an "accredited school." About four and a half years ago, approval of this institution was withdrawn following a sweeping change in the faculty by the then newly elected governor.

Committee on Fees Reports

A report of the Committee on Fees, transmitting a proposed schedule as recommended for adoption by the Executive Committee at its meeting earlier in the day on April 3, was considered. The schedule was adopted, and it was decided to publish it with the "Report on Prevailing Salaries of Civil Engineers" as a separate pamphlet. The schedule as adopted is also to be urged for official recognition by the administrators of PWA and FERA and by other public officials where fees and salaries of engineers may be of significance. The schedule is featured elsewhere in this issue.

Proposed Amendment to Society Constitution

The Board received and approved a report from a temporary Committee on Uniform Grades of Membership, consisting of Directors Perry, Barbour, and McDonald. Sitting as a committee of the whole, an amendment to the Constitution of the Society was drafted and a petition signed by all the members of the Board present. This will be issued in due course to the Corporate Membership and will be in order for discussion by the Society at the time of the Annual Convention of the Society in Los Angeles next July. It may be amended at that time in manner pertinent to the original amendment and later will be submitted to the Corporate Membership for a vote.

The principal feature of the amendment is the proposed creation of the grade of Fellow and the elimination of the grade of Associate Member. In effect the qualifications proposed for a Fellow will be somewhat more selective than those for the present grade of Member, and those for the present grade of Associate Member will be retained but the designation will be changed to Member. Provision is made for a transition period of two years during which there may be equitable transfer of present members in the respective grades. A Student Member grade is also proposed. It is the plan that all the Founder Societies, in due course, will take similar action in establishing uniform terminology and perhaps uniform qualifications for the higher and lower grades of Corporate Membership. When placed before the membership for discussion and action, the proposed amendment is to be accompanied by a statement setting forth the considerations which have led to the proposed change.

Another Constitutional Amendment

From the Committee on Publications there came the recommendation that, in view of the fact that one Constitutional amendment is to be proposed, there be prepared another petition providing for amendment to article VII, Section 6, of the Constitution whereby the printing of the list of official nominees for office in the Society, now required to appear in PROCEEDINGS, would be permissible in CIVIL ENGINEERING, thus making PROCEEDINGS a strictly technical publication and CIVIL ENGINEERING the medium for the distribution of all Society news and procedures. This was approved, and a petition is in preparation.

Reports from Joint Agencies

Communications were presented from the United Engineering Trustees, the Engineering Foundation, and the American Engineering Council outlining recent activities.

"Prevailing Salaries of Civil Engineers" Officially Approved

Under date of March 6, 1935, PWA State Engineers were circularized, calling to their attention the necessity of using the report of the Society's Committee on Salaries as a guide in determining salaries to be paid in relation to PWA activities.

The Secretary of the Society was instructed to express appreciation of this official recognition and to state that the Society would be glad to cooperate with all official agencies in any way in this matter.

Survey of the Engineering Profession

Latest developments were reported in connection with a survey of the engineering profession being developed under the sponsorship of the Committee on Engineering and Allied Technical Professions of the American Engineering Council, of which the Secretary of the Society is chairman. In the March issue of CIVIL ENGINEERING appeared a detailed statement relative to this survey.

E. C. P. D.—Certification Into the Profession

The program for certification into the engineering profession, as formulated by the Committee on Professional Recognition of the Engineers' Council for Professional Development, received the approval of the Board. Approval of the program has already been given by the American Society of Mechanical Engineers and the National Council of State Boards of Engineering Examiners. This program is featured elsewhere in this issue.

Work Relief

It was reported that the President of the Society, after securing the approval of the Executive Committee, had offered to the President of the United States the services of the American Society of Civil Engineers in any manner that might be acceptable in connection with the administration of the proposed Federal appropriation of $4,880,000,000 for relief of unemployment.

Reinstatement of Former Members

A report was presented showing that, in response to the action taken by the Board last October, whereby it was made possible for former members to be reinstated under very lenient financial terms, 239 replies have been received, expressive of a desire to come back into the Society on this basis, and that already 49 former members have been reinstated.

Visits of Officers to Local Sections

Last January budgetary provision was made for visits by officers of the Society to the Local Sections in their respective Districts and Zones, and the Secretary was instructed to advise Sections that these officers would be glad to make such visits, as far as practicable, if the Sections desire. It was reported that since the January meeting of the Board, visits have been made to the annual meeting of the Engineering Institute of Canada at Toronto, Canada; the Engineers' Club at Philadelphia; the Northeastern Section, Boston; the District of Columbia Section; the Philadelphia Section; the Student Chapter joint meeting at Virginia Military Institute, Lexington, Va.; the Georgia Section and Georgia School of Technology Student Chapter at Atlanta; the Kansas State Section at Topeka; the Kansas State College Student Chapter at Manhattan, Kans.; the University of Michigan Student Chapter at Ann Arbor; the State College of Washington Student Chapter at Pullman, Wash.; the Iowa Section at Des Moines; the University of Nebraska Student Chapter at Lincoln; the Milwaukee Section at Milwaukee, Wis.; the University of Wisconsin Student Chapter at Madison; the Washington University Student Chapter at St. Louis, Mo.; the St. Louis Local Section at St. Louis; the Maryland Section at Baltimore; and the Puerto Rico Section.

Gifts to the Society

A very attractively bound book entitled *A Diary with Reminiscences of the War and Refugee Life in the Shenandoah Valley, 1860–1865*, written by Mrs. Cornelia McDonald, mother of Past-President Hunter McDonald, annotated and supplemented by Mr. McDonald, was presented to the Society by him. The Secretary was instructed to express to him the appreciation of the Board.

J. N. Chester, former Vice-President, presented to the Society a motion-picture film which he had taken of the officers of the Society, this being a supplement to a similar film made some years ago by former Director Harry W. Dennis, in an effort to collect and preserve a photographic record of all officers of the Society. A vote of thanks was tendered to Mr. Chester.

Appointment of Secretary, Treasurer, and Assistant Treasurer

This being the second regular meeting of the Board after the

Annual Meeting, in accordance with the Constitution the appointment of a Secretary, Treasurer and Assistant Treasurer of the Society was in order. The present incumbents were reappointed, as follows: George T. Seabury, Secretary, Otis E. Hovey, Treasurer, Ralph R. Rummery, Assistant Treasurer.

Future Meetings

Invitations to hold future meetings of the Society with them in their respective localities were received from the Tennessee Valley Section, the Salt Lake City Section, the Detroit Section, the Pittsburgh and the Rochester Sections. These invitations were all referred to the respective regional meeting committees for report.

Registration of Engineers

The progress of registration of engineers in the several states was reported to the Board. Mr. Jessup, Field Secretary, reported his relationship to this matter as found in the various Local Sections which he had recently visited. He reported also his findings in regard to the breakdown or maintenance of Civil Service systems as variously discovered at places he had visited.

Membership Committee

The Board took action on 62 cases of membership admission and transfer as reported to it by the Committee on Membership Qualifications.

Miscellaneous Matters

Other administrative matters were discussed and acted upon.

Adjournment

The Board adjourned to meet at Los Angeles, Calif., on July 1, 1935.

Meeting of Executive Committee—Secretary's Abstract

On April 3, 1935, the Executive Committee met at the Miami Biltmore Hotel at Coral Gables, Miami, Fla. Those present were President Arthur S. Tuttle, Secretary Seabury, Past-Presidents Eddy and Hammond, and Vice-President Hogan. Vice-President Riggs also was present by invitation for part of the session.

Approval of Minutes

The minutes of the meeting of the Executive Committee held on January 17, 1935, were approved.

Defense of Members: Outline of Method of Procedure

In consequence of the decision of the Board to undertake, in certain instances, the defense of members unjustly accused and deprived of position without a hearing, the outline of a method of procedure to be followed was drafted and approved for recommendation to the Board.

E. C. P. D. Committee on Engineering Schools: Delegatory Committees

Approval was given to a list of nominees to represent the Society on seven delegatory committees to assist the Committee on Engineering Schools of the Engineers' Council for Professional Development (E. C. P. D.) in connection with its examination of curricula at the various engineering schools and recommendation of appropriate accrediting action to the E. C. P. D. The practical impossibility of handling the problem as a single national project has been recognized, and accordingly the country has been divided into seven geographical regions, each one of which contains approximately the same number of engineering schools. For each region there is to be set up a delegatory committee, which is to examine the school curricula, visit the institution, and make recommendation to the Committee on Engineering Schools as to accrediting.

A Junior on Every Committee of the Society

The Secretary reported progress in connection with the action of the Board taken last January looking toward the addition, as may be found practicable, of a Junior to every committee of the Society, of the Technical Divisions, and of the Local Sections.

Report on Fees

A report received from the Committee on Fees, transmitting proposed "Recommendations for Determining Fees to Be Allowed for Professional Engineering Services on Federal and Federal-Aid Projects Undertaken as an Aid to Industrial Recovery or to Relieve Unemployment," received careful consideration. The schedule, with certain minor changes, was recommended for adoption by the Board. The report appears in full elsewhere in this issue.

Miscellaneous Details

Details in respect to the sale of certain of the Society's securities, the subsequent reinvestment procedure, and other administrative details, including certain additional appropriations, received the attention of the Executive Committee.

President Tuttle's Message to Student Chapter Members

I wish to speak frankly with the members of the Student Chapters of the Society, and especially with those in the senior class. In a very few weeks you will each begin the serious business of carving out for yourself a niche in the profession. Thereafter the years will spread out behind you at an alarmingly rapid pace, and hence many of your present decisions will be the most important of your entire career. You may take it on the advice of many of the older members of your profession that failure to ally yourself promptly with a strong professional society of national scope may become the most grievous neglect that you as a young engineering graduate can make.

There is no more effective way in which to keep abreast of technical advancement in your profession than by a regular study of the technical papers produced by the American Society of Civil Engineers. Furthermore, in a few years, when you have begun to gain experience to reinforce your theoretical knowledge, you will wish to take part in technical discussion. This is an obligation you undertake when you join the Society. But beyond such a duty, this professional activity has the personal advantage of keeping the young graduate in touch with those elements which eventually will determine his advancement in engineering, and of keeping him awake to the most valuable professional thought in his field.

Recently the Board of Direction has made Junior membership in the Society more valuable by stipulating that wherever practicable the special committees of the Society shall contain one Junior in their personnel. Such service on the committees of the Society and Local Sections should be intensely appealing to the progressive type of younger engineer, and its value in offering a means of coming into intimate contact with famous and eminent men in your chosen specialty is an opportunity not to be missed.

At no time in your professional career will you find it so simple and easy to become a Junior member of the Society as at this time, particularly if you have been a member of your Student Chapter. If you are a member of any Chapter, the Society will remit your first year's dues provided your application is filed within two months from the date of your graduation. Furthermore, various Local Sections offer special inducements or prizes to Student Chapter members, paying the initiation fee or a year's dues, and in some cases both. Under some circumstances then, it is possible for Student Chapter members to become Juniors of the Society on graduation, with their initiation fee and dues for the first two years of their career paid for them.

One of the most telling evidences of the Society's consistent growth in numbers, in degree of attainment, and in professional dignity and power is the rate at which the number of Juniors increases year after year. These facts should indicate to thoughtful and ambitious young graduates the desirability of adding themselves to this progressive list. Out of such promising groups of graduates come most of the Members and Associate Members of the future.

Faithfully yours,
Arthur S. Tuttle
President, American Society of Civil Engineers

New York, N.Y.
April 15, 1935

Emergency Relief Appropriation Act of 1935

Bill Appropriating $4,880,000,000 to President for Work Relief Becomes Law

THE Society has been active in its support of public works. A very large fund for work-relief purposes has recently been provided by the Federal Government, after a long period of debate in the Senate. While the Act makes available until June 30, 1937, the sum of $4,880,000,000, it actually appropriates only $4,000,000,000, the remainder of $880,000,000 representing reappropriations to be used mainly for direct relief and for repayment of PWA fund transfers. The work relief bill was introduced in the House of Representatives January 21, 1935, and passed by an overwhelming majority three days later. It was reported to the Senate on February 14 but was returned to committee on February 22 after the adoption of the prevailing wage rate clause. On March 5 it was reported out of committee again, this time without the prevailing wage. The Senate finally adopted a compromise wage rate on March 15, passed the bill eight days later, and sent it to conference with the House. After Secretary Ickes had protested the "direct work" clause inserted by Senate conferences, the House and Senate conference finally arrived at a compromise amendment on April 4. The conference report was adopted by House and Senate on April 5, and the bill was signed by President Roosevelt on April 8. In view of its importance to the profession, the text of the Act is printed in full.

Resolved by the Senate and House of Representatives of the United States of America in Congress Assembled, That in order to provide relief, work relief and to increase employment by providing for useful projects, there is hereby appropriated, out of any money in the Treasury not otherwise appropriated, to be used in the discretion and under the direction of the President, to be immediately available and to remain available until June 30, 1937, the sum of $4,000,000,000, together with the separate funds established for particular areas by proclamation of the President pursuant to section 15 (*f*) of the Agricultural Adjustment Act (but any amounts thereof shall be available for use only for the area for which the fund was established); not exceeding $500,000,000 in the aggregate of any savings or unexpended balances in funds of the Reconstruction Finance Corporation; and not exceeding a total of $380,000,000 of such unexpended balances as the President may determine are not required for the purposes for which authorized, of the following appropriations, namely: The appropriation of $3,300,000,000 for national industrial recovery contained in the Fourth Deficiency Act, fiscal year 1933, approved June 16, 1933 (48 Stat. 274); the appropriation of $950,000,000 for emergency relief and civil works contained in the Act approved February 15, 1934 (48 Stat. 351); the appropriation of $899,675,000 for emergency relief and public works, and the appropriation of $525,000,000 to meet the emergency and necessity for relief in stricken agricultural areas, contained in the Emergency Appropriation Act, fiscal year 1935, approved June 19, 1934 (48 Stat. 1055); and any remainder of the unobligated moneys referred to in section 4 of the Act approved March 31, 1933 (48 Stat. 22):

Provided, That except as to such part of the appropriation made herein as the President may deem necessary for continuing relief as authorized, under the Federal Emergency Relief Act of 1933, as amended, or for restoring to the Federal Emergency Administration of Public Works any sums which after December 28, 1934, were, by order of the President impounded or transferred to the Federal Emergency Relief Administration from appropriations heretofore made available to such Federal Emergency Administration of Public Works (which restoration is hereby authorized), this appropriation shall be available for the following classes of projects, and the amounts to be used for each class shall not, except as hereinafter provided, exceed the respective amounts stated, namely:

a) Highways, roads, streets, and grade-crossing elimination, $800,000,000;

b) Rural rehabilitation and relief in stricken agricultural areas, and water conservation, trans-mountain water diversion and irrigation and reclamation, $500,000,000;

c) Rural electrification, $100,000,000;

d) Housing, $450,000,000;

e) Assistance for educational, professional, and clerical persons, $300,000,000;

f) Civilian Conservation Corps, $600,000,000;

g) Loans or grants, or both, for projects of States, Territories, Possessions, including subdivisions and agencies thereof, municipalities, and the District of Columbia, and self-liquidating projects of public bodies thereof, where, in the determination of the President, not less than twenty-five per centum of the loan or the grant, or the aggregate thereof, is to be expended for work under each particular project, $900,000,000;

h) Sanitation, prevention of soil erosion, prevention of stream pollution, sea coast erosion, reforestation, forestation, flood control, rivers and harbors and miscellaneous projects, $350,000,000:

Provided further, That not to exceed 20 per centum of the amount herein appropriated may be used by the President to increase any one or more of the foregoing limitations if he finds it necessary to do so in order to effectuate the purpose of this joint resolution:

Provided further, That no part of the appropriation made by this joint resolution shall be expended for munitions, warships, or military or naval material; but this proviso shall not be construed to prevent the use of such appropriation for new buildings, reconstruction of buildings and other improvements in military or naval reservations, posts, forts, camps, cemeteries, or fortified areas, or for projects for non-military or non-naval purposes in such places.

Except as hereinafter provided, all sums allocated from the appropriation made herein for the construction of public highways and other related projects (except within or adjacent to national forests, national parks, national parkways, or other Federal reservations) shall be apportioned by the Secretary of Agriculture in the manner provided by section 204 (*b*) of the National Industrial Recovery Act for expenditure by the State highway departments under the provisions of the Federal Highway Act of November 9, 1921, as amended and supplemented, and subject to the provisions of section 1 of the Act of June 18, 1934 (48 Stat. 993):

Provided, That any amounts allocated from the appropriation made herein for the elimination of existing hazards to life at railroad grade crossings, including the separation or protection of grades at crossings, the reconstruction of existing railroad grade crossing structures, and the relocation of highways to eliminate grade crossings, shall be apportioned by the Secretary of Agriculture to the several States (including the Territory of Hawaii and the District of Columbia), one-half on population as shown by the latest decennial census, one-fourth on the mileage of the Federal-aid highway system as determined by the Secretary of Agriculture, and one-fourth on the railroad mileage as determined by the Interstate Commerce Commission, to be expended by the State highway departments under the provisions of the Federal Highway Act of November 9, 1921, as amended and supplemented, and subject to the provisions of section 1 of such Act of June 18, 1934 (48 Stat. 993); but no part of the funds apportioned to any State or Territory under this joint resolution for public highways and grade crossings need be matched by the State or Territory:

And provided further, That the President may also allot funds made available by this joint resolution for the construction, repair, and improvement of public highways in Alaska, Puerto Rico, and the Virgin Islands, and money allocated under this joint resolution

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to relief agencies may be expended by such agencies for the construction and improvement of roads and streets:

Provided, however, That the expenditure of funds from the appropriation made herein for the construction of public highways and other related projects shall be subject to such rules and regulations as the President may prescribe for carrying out this paragraph and preference in the employment of labor shall be given (except in executive, administrative, supervisory, and highly skilled positions) to persons receiving relief, where they are qualified, and the President is hereby authorized to predetermine for each State the hours of work and the rates of wages to be paid to skilled, intermediate, and unskilled labor engaged in such construction therein:

Provided further, That rivers and harbors projects, reclamation projects (except the drilling of wells, development of springs and subsurface waters), and public buildings projects undertaken pursuant to the provisions of this joint resolution shall be carried out under the direction of the respective permanent Government departments or agencies now having jurisdiction of similar projects.

Funds made available by this joint resolution may be used, in the discretion of the President, for the purpose of making loans to finance, in whole or in part, the purchase of farm lands and necessary equipment by farmers, farm tenants, croppers, or farm laborers. Such loans shall be made on such terms as the President shall prescribe and shall be repaid in equal annual instalments, or in such other manner as the President may determine.

Funds made available by this joint resolution may be used, in the discretion of the President for the administration of the Agricultural Adjustment Act, as amended, during the period of 12 months after the effective date of this joint resolution.

Section 2. The appropriation made herein shall be available for use only in the United States and its Territories and possessions. The provisions of the Act of February 15, 1934 (48 Stat. 351), relating to disability or death compensation and benefits shall apply to those persons receiving from the appropriation made herein, for services rendered as employees of the United States, security payments in accordance with schedules established by the President:

Provided, That so much of the sum herein appropriated as the United States Employees' Compensation Commission, with the approval of the President, estimates and certifies to the Secretary of the Treasury will be necessary for the payment of such compensation and administrative expenses shall be set aside in a special fund to be administered by the Commission for such purposes; and after June 30, 1936, such special fund shall be available for these purposes annually in such amounts as may be specified therefor in the annual appropriation Acts. The provisions of section 3709 of the Revised Statutes (U. S. C., title 41, sec. 5) shall not apply to any purchase made or service procured in carrying out the provisions of this joint resolution when the aggregate amount involved is less than $300.

Section 3. In carrying out the provisions of this joint resolution the President may (*a*) authorize expenditures for contract stenographic reporting services; supplies and equipment; purchase and exchange of law books, books of reference, directories, periodicals, newspapers and press clippings; travel expenses, including the expense of attendance at meetings when specifically authorized; rental at the seat of government and elsewhere; purchase, operation, and maintenance of motor-propelled passenger-carrying vehicles; printing and binding; and such other expenses as he may determine necessary to the accomplishment of the objectives of this joint resolution; and (*b*) accept and utilize such voluntary and uncompensated services, appoint, without regard to the provisions of the civil-service laws, such officers and employees, and utilize such Federal officers and employees, and, with the consent of the State, such State and local officers and employees, as may be necessary, prescribe their authorities, duties, responsibilities, and tenure, and, without regard to the Classification Act of 1923, as amended, fix the compensation of any officers and employees so appointed.

Any Administrator or other officer, or the members of any central board, or other agency, named to have general supervision at the seat of Government over the program and work contemplated under the appropriation made in section 1 of this joint resolution and receiving a salary of $5,000 or more per annum from such appropriation, and any State or regional administrator receiving a salary of $5,000 or more per annum from such appropriation (except persons now serving as such under other law), shall be appointed by the President, by and with the advice and consent of the Senate:

Provided, That the provisions of section 1761 of the Revised Statutes shall not apply to any such appointee and the salary of any person so appointed shall not be increased for a period of six months after confirmation.

Section 4. In carrying out the provisions of this joint resolution the President is authorized to establish and prescribe the duties and functions of necessary agencies within the Government.

Section 5. In carrying out the provisions of this joint resolution the President is authorized (within the limits of the appropriation made in section 1) to acquire, by purchase or by the power of eminent domain, any real property or any interest therein, and improve, develop, grant, sell, lease (with or without the privilege of purchasing), or otherwise dispose of any such property or interest therein.

Section 6. The President is authorized to prescribe such rules and regulations as may be necessary to carry out this joint resolution, and any willful violation of any such rule or regulation shall be punishable by fine of not to exceed $1,000.

Section 7. The President shall require to be paid such rates of pay for all persons engaged upon any project financed in whole or in part, through loans or otherwise, by funds appropriated by this joint resolution, as will in the discretion of the President accomplish the purposes of this joint resolution, and not affect adversely or otherwise tend to decrease the going rates of wages paid for work of a similar nature.

The President may fix different rates of wages for various types of work on any project, which rates need not be uniform throughout the United States:

Provided, however, That whenever permanent buildings for the use of any department of the Government of the United States, or the District of Columbia, are to be constructed by funds appropriated by this joint resolution, the provisions of the Act of March 3, 1931 (U. S. C., Supp. VII, title 40, sec. 276a), shall apply but the rates of wages shall be determined in advance of any bidding thereon.

Section 8. Wherever practicable in the carrying out of the provisions of this joint resolution, full advantage shall be taken of the facilities of private enterprise.

Section 9. Any person who knowingly and with intent to defraud the United States makes any false statement in connection with any application for any project, employment, or relief aid under the provisions of this joint resolution, or diverts, or attempts to divert, or assists in diverting for the benefit of any person or persons not entitled thereto, any moneys appropriated by this joint resolution, or any services or real or personal property acquired thereunder, or who knowingly, by means of any fraud, force, threat, intimidation, or boycott, deprives any person of any of the benefits to which he may be entitled under the provisions of this joint resolution, or attempts so to do, or assists in so doing, shall be deemed guilty of a misdemeanor and shall be fined not more than $2,000 or imprisoned not more than one year, or both.

Section 10. Until June 30, 1936, or such earlier date as the President by proclamation may fix, the Federal Emergency Relief Act of 1933, as amended, is continued in full force and effect.

Section 11. No part of the funds herein appropriated shall be expended for the administrative expenses of any department, bureau, board, commission, or independent agency of the Government if such administrative expenses are ordinarily financed from annual appropriations, unless additional work is imposed thereupon by reason of this joint resolution.

Section 12. The Federal Emergency Administration of Public Works established under title II of the National Industrial Recovery Act is hereby continued until June 30, 1937, and is authorized to perform such of its functions under said Act and such functions under this joint resolution as may be authorized by the President. All sums appropriated to carry out the purposes of said Act shall be available until June 30, 1937. The President is authorized to sell any securities acquired under said Act or under this joint resolution and all moneys realized from such sales shall be available to the President, in addition to the sums heretofore appropriated under this joint resolution, for the making of further loans under said Act or under this joint resolution.

Section 13. (*a*) The acquisition of articles, materials, and supplies for the public use, with funds appropriated by this joint resolution, shall be subject to the provisions of section 2 of title III of the Treasury and Post Office Appropriation Act, fiscal year 1934; and all contracts let pursuant to the provisions of this joint

of New York, and Virginia Military Institute. The Society was

Certification Into the Profession

resolution shall be subject to the provisions of section 3 of title III of such Act.

(*b*) Any allocation, grant, or other distribution of funds for any project, Federal or non-Federal, from the appropriation made by this joint resolution, shall contain stipulations which will provide for the application of title III of such Act to the acquisition of articles, materials, and supplies for use in carrying out such project.

Section 14. The authority of the President under the provisions of the Act entitled "An Act for the relief of unemployment through the performance of useful public work, and for other purposes," approved March 31, 1933, as amended, is hereby continued to and including March 31, 1937.

Section 15. A report of the operations under this joint resolution shall be submitted to Congress before the 10th day of January in each of the next three regular sessions of Congress, which report shall include a statement of the expenditures made and obligations incurred, by classes and amounts.

Section 16. This joint resolution may be cited as the "Emergency Relief Appropriation Act of 1935."

Approved, April 8, 1935, 4 p.m.

Procedure in Defense of Members

A NUMBER OF cases have occurred within the past year or two, in which members have been accused, condemned, and usually deprived of their positions, too frequently without an adequate hearing. Responsive to this serious situation, the Board of Direction, at its January meeting, approved the principle that the Society should defend such members. The conditions and procedure under which this defense might be undertaken were recommended by the Executive Committee at its April 3, 1935, meeting and approved by the Board that same evening. These contemplated activities as presented to, and approved by the Board are given in the following outline.

In an effort to maintain and improve the present high standing of the engineering profession and the recognition of said professional standing by the public:

I. *Scope*

a) The American Society of Civil Engineers will undertake to defend its members against unjust accusation or dismissal, or oppression, without justification or proper hearing.

b) Defense of members will be limited to instances imputing character or technical dereliction of one or more related persons, and to the

c) Defense of segregated groups of engineers in matters pertaining to conditions of their employment.

d) Defense will not extend to action at law.

e) Defense will not be undertaken in instances involving infringement of patents, plagiarism, monetary considerations related to disputed bill, fee, violation of contract or other instance where redress is properly to be attained through legal process, nor will defense be initiated or continued where legal counsel has been retained to secure redress except as such legal counsel may be retained by segregated groups of engineers in relation to conditions of their employment.

f) It is to be understood by all concerned that favorable outcome shall not be expected to result in the reemployment of discharged persons, but it may equally be understood by all concerned that favorable outcome will constitute a public vindication to be recognized as such by the engineering profession.

g) It is to be understood too that unfavorable outcome shall be made known to only the one or ones believing themselves to be aggrieved.

h) The right is reserved to abstain from or to discontinue, without explanation, any investigation.

II. *Procedure*

a) Cases shall originate with a "petitioner" who shall make a written "statement" of his view of the case, fully self-contained in one document with such exhibits as he believes to be helpful (4 copies).

b) The petitioner's statement shall be reviewed by the Executive Committee of the Local Section of the Society most intimately related to the location where the basic cause of the case arises.

c) The Executive Committee of the Local Section shall transmit to the Secretary of the Society the petitioner's statement, and a copy of the Committee's "conclusions," with supporting evidence, together with a "request" for an "investigation," if such investigation is recommended, the request to indicate definitely the degree in which the conclusions are acceded to by the full membership of the Executive Committee of the Section (3 copies).

d) Action by the petitioner and by the Executive Committee of the Local Section must be prompt.

e) The responsibility for the inauguration of an investigation shall rest upon the Executive Committee of the Society.

f) The "investigator" shall be the Vice-President of the Zone which embraces the Local Section concerned, unless through some occasion for embarrassment, or impracticability, he cannot personally so act. In such event the investigator shall be such member of the Society as the President of the Society shall designate and who shall be deemed to be without either personal knowledge of or personal interest in the case.

g) The investigator, at Society expense, shall promptly enter upon his investigation, personally to interview the petitioner, the members of the Executive Committee of the Local Section concerned, and other persons who, it shall appear to him, can help him to a just determination.

h) While the statement of the petitioner will indicate the subject matter of the investigation, the investigator need not confine his inquiries to the topics set forth in the statement. His "report," however, shall present his conclusions with respect to only the specific complaint.

i) The investigator shall transmit his report (4 copies) in typewritten form, with or without exhibits, to the Secretary of the Society.

j) The Executive Committee of the Society shall use its discretion as to the release of the report and as to subsequent procedure.

Student Chapter Convention at Swarthmore College

SWARTHMORE COLLEGE, 12 miles southeast of Philadelphia, was host on April 17, 1935, to nearly 200 delegates from twelve Student Chapters located in the vicinity of Philadelphia. After registration at Hicks Hall, the guests were welcomed by Dr. Frank Aydelotte, president of the college. The convention was sponsored by the Philadelphia Section of the Society and was the first of a proposed series of annual events. During the technical sessions a student from each Chapter presented a paper, limiting in length to 15 minutes for its delivery.

It has long been the custom of the Philadelphia Section to offer three annual prizes for the best student papers submitted in competition—the award being in the form of initiation fees and first year's dues for Junior membership in the Society payable at the time the student is accepted for membership. But this year the Section offered, in addition, a \$20 cash prize for the best paper. The decision was left to a secret weighted ballot by the audience itself, based on such factors as facility of expression, clearness of presentation, excellence of the paper, necessity for the use of manuscript, and technic of overcoming any difficulties in presenting lantern slides and mathematical derivations.

It might have been thought that voting delegates would favor the speaker from their own Chapter, but by a vote of nearly half those cast, the prize went to H. F. Redmile, a senior and member of the Student Chapter of the University of Delaware, who spoke on the subject, "Tests of Concrete Slabs Reinforced with Wire Mesh."

Luncheon was served in the college dining room. The laboratories of the College of Engineering were open for inspection, and just as much interest was shown in them by the visiting professors and members of the Society from Philadelphia as by the student delegates themselves. In the evening the students from the convention were guests of the Philadelphia Section at the Engineers' Club, first at dinner, then at a later session devoted to stunts by the various Chapters. A feature of these stunts was the projection on the screen of snapshots of individuals attending the conference taken during the day. At this time Isaac S. Walker, president of the Section, presented the prize check to Mr. Redmile. An illustrated lecture on the construction of the dome of the New York planetarium given at this time by R. L. Bertin, M. Am. Soc. C.E., elicited considerable interesting discussion from members and students.

Delegates attended the convention from Bucknell University, University of Delaware, Drexel Institute, Pennsylvania Military College, Pennsylvania State College, University of Pennsylvania, Swarthmore College, Villanova College, Lehigh University, Newark College of Engineering, New York University, College of the City

state or territory having statutory requirements at least the equal of those specified in the Model Registration Law.

bodied in the "Minimum Definition of an Engineer," with the provision that no new applicants shall be

of New York, and Virginia Military Institute. The Society was represented by Walter E. Jessup, Field Secretary, who spoke briefly at the afternoon session. The value of the contacts and interchange of ideas between Chapters and Section members was increased because of the careful planning of Scott B. Lilly, M. Am. Soc. C.E., Professor of Civil Engineering at Swarthmore College.

Florida Engineering Society Meets

THE NINETEENTH Annual Meeting of the Florida Engineering Society held at the Miami Biltmore Hotel, Coral Gables, Fla., April 4–6, 1935, took on a special interest because of the presence of many members of the American Society of Civil Engineers. Just previously, the Board of Direction and its various committees had, themselves, gathered at the same hotel in connection with regular business. Many members of the Board as well as other Society officers, with their families, swelled the attendance and interest of the meeting. Further additions were contributed by a number of members of the Society, comprising the Florida and Miami Sections, who took advantage of this opportunity not only to meet Board members but to enjoy the sessions of the Florida Engineering Society. Also in attendance were a generous number of members from the Student Chapter of the Society at the University of Florida, Gainesville, Fla.

In all, the gathering had a rather general civil engineering character. Many of the sessions and talks were devoted to civil engineering subjects. At the same time meetings of local groups of both mechanical and electrical engineers were held. Then, too, the American Shore and Beach Preservation Association joined in one of the sessions, with a large attendance, including many officers of the Engineer Corps of the U. S. Army.

From the standpoint of the Society, one of the interesting gatherings was a joint breakfast arranged for Friday morning, April 5. All local Society members were invited and a great many were in attendance. The Student Chapter members also took advantage of this opportunity to meet with the others, so that throughout the dining room of the Miami Biltmore Hotel a number of interested groups were gathered. As this is the first occasion at which the Board or any other organization representing the Society as a whole has met in Florida, the entire program was a source of distinct pleasure and gratification. President Arthur S. Tuttle addressed the Friday morning session, April 5, while at the annual dinner that same evening the Society was represented by President Tuttle, Past-Presidents Eddy and Hammond, and Secretary Seabury, all of whom spoke. Also of interest were the remarks offered by Secretary of War Dern at the Friday morning session.

Many Society members, including residents of Florida and the large number of outside visitors will long recall these interesting meetings and social events amid delightful surroundings.

National Survey of Engineering Progresses

QUESTIONNAIRES to determine the classification of every member of the engineering profession will be mailed at an early date, according to an announcement of the Bureau of Labor Statistics. Priority given to other current surveys has postponed the earlier mailing of the questionnaires, but these are now printed, and the addressing of the envelopes is nearly completed. All engineers are requested to answer the questionnaire carefully and completely and to return it promptly to the Bureau in Washington.

Early in March the questionnaire itself was re-submitted to the originating group of engineers in charge of the work, and a final draft was completed on March 16. The last three items in the questionnaire pertain to classification of engineers. An interesting system of tabulation has been worked out whereby the individual will be asked to classify himself first as to industry, service, or zone of interest; second, as to function in that industry; and third, as to the branch of engineering in which he is practicing, such as civil, mechanical, electrical. Such classification is only one of the several types of information which it is hoped will be obtained.

Approximately 175,000 questionnaires will be mailed. Any member of the profession who fails to receive one should communicate with the Bureau of Labor Statistics, Survey of the Engineering Profession, Washington, D.C.

Certification Into the Profession

Program Proposed for Committee on Professional Development of the Engineers' Council for Professional Development

INTRODUCTION

1. It is recognized that the reexamination of the many thousands of men already established in the profession is impracticable, and that the equivalent of a "grandfather clause" must be applied to permit a virtually automatic certification of those who are now recognized and already accepted as engineers by duly constituted legal authorities and by the profession.

2. It is further recognized that a reasonable transition period must be allowed for the progressive adjustment of present standards and criteria and for the setting up and effectuation of the mechanics of examination and individual certification before the new standard embodied in the Engineers' Council for Professional Development (E. C. P. D.) "Miniumum Definition of an Engineer" can be fully and literally applied.

3. It is therefore necessary to plan a practical program of certification covering the transition period, with progressive adjustment of requirements and successive tightening of standards, always keeping in view, as a goal, the early and complete effectuation of the E. C. P. D. standards and program of individual certification as applied to new members of the profession.

4. With the foregoing considerations in mind, the following program of certification is recommended for adoption in order to provide smooth, practical transition from present operating procedure to the procedure projected by the E. C. P. D

PROGRAM

1. It is recommended that the E. C. P. D. be authorized to publish an annual roster of all engineers certified by it. No filing fees should be charged for listing in the roster, but a charge should be made for copies of this directory to defray the cost of assembling and printing. This roster should preferably list the engineers geographically, by states and territories, and also in a comprehensive alphabetic index. The main listings should give the names, educational degrees, professional designations, and addresses of the certified engineers. The roster will list between 40,000 and 100,000 engineers.

2. It is recommended that the E. C. P. D. be authorized to offer to certified engineers a certificate suitable for framing and display. For any such certificates ordered, a fee should be charged sufficient to defray the cost.

3. It is recommended that the E. C. P. D. be authorized to notify all engineers when they are certified, requesting the filling out of a card with the information desired for the roster and enclosing order blanks for rosters and certificates.

4. Until January 1, 1936, the following engineers should be granted certification by the E. C. P. D.:

a) All those who are registered or licensed as engineers by the legally constituted authorities of any state or territory of the United States.

b) All those who have been granted certification by the National Bureau of Engineering Registration.

c) All those who are enrolled in the following grades of membership in the following national engineering societies:

American Society of Civil Engineers . . . .Associate Member, Member, Honorary Member
American Society of Mechanical Engineers. .Associate Member, Member, Honorary Member
American Institute of Electrical Engineers. . Member, Fellow, Honorary Member
American Institute of Mining and Metallurgical Engineers. . . . . Member, Honorary Member
American Institute of Chemical Engineers. . . Active Member

d) All those who have once been qualified under (*a*), (*b*) and (*c*) may be granted certificates on application.

e) Nothing in the previous paragraphs shall be construed as qualifying for certification any person whose license or membership has ever been revoked for unprofessional conduct.

5. Until January 1, 1937, the following engineers should be granted certification by the E. C. P. D. (in addition to those previously certified by it):

a) All those who are registered or licensed as engineers in any

Means for Developing the Engineering Profession

THE E. C. P. D. PLANS TO GUIDE STUDENTS, ACCREDIT

and the American Society of Mechanical Engineers, approved in principle the minimum definition of an engineer proposed by the

state or territory having statutory requirements at least the equal of those specified in the Model Registration Law.

b) All those who are certified by the National Bureau of Engineering Registration as having met the requirements specified in the Model Registration Law.

c) All those who are admitted to the following (or equivalent) grades of membership in the following national engineering societies:

American Society of Civil Engineers. . . .Associate Member, Member, Honorary Member
American Society of Mechanical Engineers. . Associate Member, Member, Honorary Member
American Institute of Electrical Engineers. . .Member, Fellow, Honorary Member
American Institute of Mining and Metallurgical Engineers . . . . .Member, Honorary Member
American Institute of Chemical Engineers . . Active Member

6. After January 1, 1937, certification by the E. C. P. D. should be only on individual application. By that date the E. C. P. D. should have set up a Bureau of Certification with a secretary and staff to receive and review applications, to check references and credentials, and to conduct examinations. (It may be desirable to make this a joint agency with the National Bureau of Engineering Registration, which is already functioning in such capacity.) A fee should be charged for each application and examination, and a smaller fee for each reconsideration or reexamination requested by the applicant. These fees should be no larger than necessary to make the E. C. P. D. Bureau self-supporting. Each applicant must submit, on suitable forms prepared and furnished by the E. C. P. D., full information on education and experience, with names of references for verification.

7. Until January 1, 1938, the E. C. P. D. Bureau of Certification may waive either written or oral examination, or both, in the case of applicants of obvious fitness as evidenced by their records of performance.

8. After January 1, 1938, certification of the E. C. P. D. should be strictly on the full requirements of the E. C. P. D. standard as embodied in the "Minimum Definition of an Engineer," with the provision that no new applicants shall be excused from examination. The submission of a satisfactory original thesis or published professional paper covering an engineering project executed by the applicant and preferably including an analysis of economic aspects of the project, may be accepted as the equivalent of the required written technical examination. The submission of a certified list of courses taken and books studied on cultural, civic, and economic subjects, together with a satisfactory original essay or published paper on a cultural, civic, or economic subject, may be accepted as the equivalent of the required written examination on economic and cultural subjects. The oral examination may be conducted by a local committee of two or more engineers or engineering educators, designated by the E. C. P. D., and should include a test-review of the applicant's recent reading in cultural and economic subjects, of his continued post-college study of technical subjects, and of his professional growth through observation and experience in his daily work.

9. Arrangements should be made, so far as practicable, to secure agreements to recognize E. C. P. D. certification as "prima facie" evidence of qualification for registration or licensing by state boards and for admission to the corporate membership grade (preferably designated "Member") in the national engineering societies. Such agreements to recognize E. C. P. D. certification should be mentioned in the announcements and printed matter of the E. C. P. D.

10. The foregoing time schedule for the progressive development of the E. C. P. D. program of certification is planned to allow necessary time for the development to functioning of the other activities of the E. C. P. D., including specifically the accrediting of engineering schools and the post-college training of recent graduates. So far as practicable, the development of these other activities of the E. C. P. D. should be timed so as not to delay the putting into operation of the program of certification as herein scheduled.

The goal should be complete functioning of the E. C. P. D. program in its interrelated functions by January 1, 1938.

Approved by the Board of Direction of the Society on April 4, 1935.

P. H. Carlin Becomes Editor of Civil Engineering

Beginning with the current issue, the editorial work for Civil Engineering is in charge of P. H. Carlin, Assoc. M. Am. Soc. C.E. Mr. Carlin succeeds Walter E. Jessup, M. Am. Soc. C.E., who has assumed the duties of Field Secretary of the Society.

To his new work Mr. Carlin brings excellent technical training, considerable engineering experience, and a knowledge of Society affairs and editorial practice. A native of Philadelphia, he is a graduate of the University of Pennsylvania with the degrees of bachelor of science in civil engineering in 1922 and civil engineer in 1930. He also has studied law at Temple University and is a registered professional engineer in Pennsylvania.

Much of Mr. Carlin's experience has been with the Philadelphia Department of City Transit, where he was engaged from 1924 through 1932 on the design of subways and particularly in writing specifications for subways and their appurtenances, including tube structures, electric sub-stations, administrative and shop buildings, track work, station finish, and operating equipment. He has also filled a number of shorter engagements in building and highway design and construction.

Following his work on Philadelphia subways, Mr. Carlin was for some time with C. E. Myers, M. Am. Soc. C.E., consulting engineer of Philadelphia, working on specifications for highways, and for sewage disposal and water supply plants. His latest engagement before taking up the duties of editor of Civil Engineering was with the Pennsylvania State Emergency Relief Board as assistant director, Luzerne County Work Division, with headquarters at Wilkes-Barre.

He has long been a member of the Philadelphia Section and has been active locally in the promotion of Society work as editor since 1931 of that Section's monthly publication, *The News*, which he has expanded into an attractive 8-page form. It is believed that under Mr. Carlin's direction Civil Engineering will maintain its prominent position among technical and professional society publications.

Gain for Engineers' Licensing in New York

An amendment to the Engineering License Law in New York State was passed by the legislature during its 1935 session and signed by Governor Lehman on April 16. Known as the Dunnigan Law, on account of its sponsor, Senator John J. Dunnigan, it provides that the practice of engineering in the state shall be further restricted to those with legitimate qualifications.

Formerly it was possible to avoid the necessity of being licensed by the simple expedient of incorporating as an engineering firm. The new bill prevents this patent subterfuge by requiring that no further corporations to practice professional engineering or land surveying, or even to use the terms "engineer" or "engineering" in its name, shall be formed. It does permit, however, the name "engineering" for non-profit-making associations whose membership comprises professional engineers. Further restrictions are likewise placed on existing engineering corporations, requiring that executives and "engineers" shall be in fact licensed professional engineers.

These and similar restrictions are provided to ensure that the title and privileges of engineers may be safeguarded. The various implications of this new legislation were explained to members of the Metropolitan Section on April 17, 1935, by D. B. Steinman, M. Am. Soc. C.E. A number of organizations, including the Society, and particularly the New York State Society of Professional Engineers, supported this reform.

SIXTY-FIFTH ANNUAL CONVENTION, July 3, 4, and 5, 1935, in Los Angeles, Calif.

American Engineering Council

munities for the FERA before coming with the Council. Previously he was executive secretary of the District of Columbia

Means for Developing the Engineering Profession

The E. C. P. D. Plans to Guide Students, Accredit Schools, and Promote Professional Status

Developments in the cooperative program of engineering societies, educators, and representatives of state engineering licensing boards looking toward the improvement of the engineering profession and the enhancement of the status of its members are recorded in the second annual report of the Engineers' Council for Professional Development (E. C. P. D.), published Aprill 5, 1935. The report, copies of which may be obtained at a cost of 25 cents each from the Secretary of the Council, at its headquarters, 29 West 39th Street, New York, N.Y., is a pamphlet of 44 pages and includes four individual reports of the Council's principal committees—on student selection and guidance, engineering schools, professional training, and professional recognition.

The E. C. P. D. is a conference of engineering bodies organized to enhance the professional status of the engineer through the cooperative support of the national organizations directly representing the professional, technical, educational, and legislative phases of an engineer's life. The participating bodies are the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, the Society for the Promotion of Engineering Education, the American Institute of Chemical Engineers, and the National Council of State Boards of Engineering Examiners.

The executive committee for 1935 is composed of C. F. Hirshfeld, chairman; J. Vipond Davies, M. Am. Soc. C.E.; F. M. Becket; W. E. Wickenden; C. F. Scott; H. C. Parmelee; R. I. Rees; and D. B. Steinman, M. Am. Soc. C.E. The secretary for this year is George T. Seabury, Secretary of the American Society of Civil Engineers.

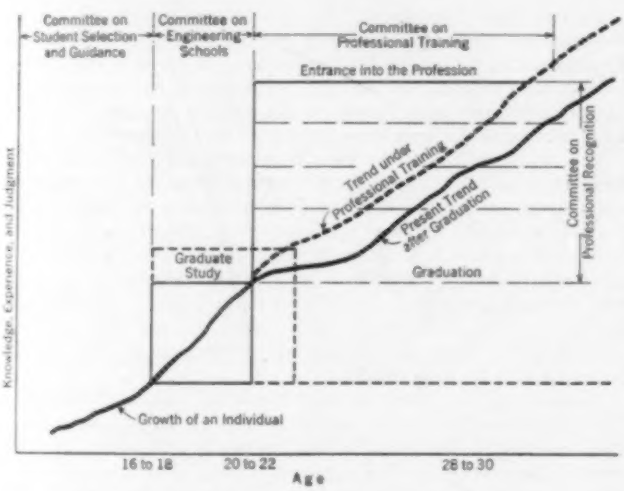


Fig. 1. How E. C. P. D. Helps the Engineer

The activities of the four major committees of the Council are organized to cover the educational and professional needs of the engineer from the time he is a student in a secondary school, faced with the problem of entering upon a college education leading to a professional career, to the time when he shall have developed in the practice of his chosen branch of the engineering profession to such an extent that he is eligible for registration or license to practice engineering under the laws of his state and for membership in one of the professional engineering societies. The accompanying diagram (Fig. 1) indicates the areas of influence in the engineer's life to which the activities of these four committees are related.

In their capacities as chairman and secretary, respectively, of the Council for 1934, C. F. Hirshfeld, director of research, Detroit Edison Company, and C. E. Davies, secretary of the American Society of Mechanical Engineers, call attention in the main report to the progress made during the year. The seven participating bodies approved the recommendation that the E. C. P. D. be established as an accrediting agency for schools of engineering. Two of the participating societies, the American Society of Civil Engineers and the American Society of Mechanical Engineers, approved in principle the minimum definition of an engineer proposed by the Council and are considering acceptance of the proposed standard nomenclature and grades of membership in engineering societies. The National Council of State Boards of Engineering Examiners also approved the definition.

Aided by a grant of $2,800 from the Engineering Foundation for publications and for the work being conducted in student selection and guidance, in post-college training and development, and in professional recognition, the E. C. P. D. was able, during 1934, to supplement and extend the voluntary efforts of its numerous committee members. As a result, substantial progress is noted in the reports of the Council's four major committees.

Reports of Four Main Committees

In his report as chairman of the Committee on Student Selection and Guidance, R. L. Sackett, M. Am. Soc. C.E., dean of the College of Engineering, Pennsylvania State College, notes that during 1934 the committee concerned itself with three major problems: The selection of a suitable booklet for informing high-school and secondary-school students about engineering; consideration of ways and means whereby this booklet could be used to the best advantage by students in secondary schools; and the development of some means whereby boys qualified to take up engineering could be selected from among those who apply for entrance to engineering schools. Dean Sackett's report also describes three experiments in guidance conferences for secondary-school students.

Setting up a procedure by means of which the accrediting of schools of engineering may be undertaken by the E. C. P. D. is described by Dr. Karl T. Compton, president, Massachusetts Institute of Technology, in the report of the Committee on Engineering Schools, of which he is chairman. Supplementing the report is the complete questionnaire to be used by the committee in securing the basic facts with respect to the engineering school seeking to be accredited by the E. C. P. D. Accrediting of schools is contingent upon a satisfactory report from the visiting committees, to be called delegatory committees, each composed of both engineering teachers and practicing engineers. This report is to be based upon an actual inspection of the school's facilities. Five of the participating bodies have already designated members for these committees.

For the year's activities of the Committee on Professional Training, its chairman, Gen. Robert I. Rees, assistant vice-president, American Telephone and Telegraph Company, New York, N.Y., reports a comprehensive method by which junior engineers may make a personal appraisal of themselves. Searching questions to be answered by the individual cover his occupation and his personal and professional status and provide the basis for formulating a general and an immediate program for his own development. Another accomplishment of the committee is the revision of an annotated reading list of more than one hundred carefully selected books covering a broad range of non-engineering subjects.

Two major efforts of the Committee on Professional Recognition, whose chairman is Conrad N. Lauer, president, Philadelphia Gas Works, Philadelphia, Pa., were devoted to the adoption of a tentative draft of a program of certification into the engineering profession, and the explanation of the committee's proposed definition of the term "engineer" and of its suggested standard grades of membership in engineering societies. The committee's program of certification into the profession covers not only the procedure to be followed after January 1, 1938, when the complete E. C. P. D. plan should be in operation, but also during the intervening transition period. For example, it is proposed that until January 1, 1936, certification shall be granted by the E. C. P. D. to all those registered or licensed as engineers by the legally constituted authorities of any state or territory; to all those who have been certified by the National Bureau of Engineering Registration; to all those now enrolled in any of the national engineering societies in grades of associate member or higher; and finally, to every person who has once been qualified under any of the preceding classifications, unless his license or membership was ever revoked for unprofessional conduct.

In addition to the reports of the four major committees, the main report also includes the charter and rules of procedure of the E. C. P. D., the verbatim statement of five policies previously adopted by it, and the complete personnel of the Council and all its committees. The report is thus a complete and authoritative source of information on the work and organization of this body.

Virginia Conference of Student Chapters

Defense of Two Members Under Way

Following closely on the decision of the Board of Direction last

American Engineering Council

The Washington Embassy for Engineers, the National Representative of 222 National, State, and Local Engineering Societies Located in 41 States.

Work Relief Bill Becomes Law

The $4,880,000,000 Work Relief Bill signed by President Roosevelt on April 8 gives the President all the money and most of the powers he first asked. To engineers this measure brings deep responsibilities, for without engineering technic such a program could be neither planned nor executed. It brings complex problems of professional status and of adjustment to new lines of activity.

The engineering nature of the program becomes evident from the type of projects earmarked in the bill. The $4,880,000,000 represents an appropriation of $4,000,000,000 plus the release of approximately $880,000,000 from past appropriations. The latter sum is mainly for continuance of relief through June 30 and for repayment of PWA funds temporarily used for relief while passage of the bill hung fire. Allocation of the $4,000,000,000 is as follows:

Highways, roads, grade crossings	$ 800,000,000
Rural rehabilitation and relief in stricken areas, water conservations, trans-mountain water diversion, irrigation, reclamation	500,000,000
Rural electrification	100,000,000
Housing	450,000,000
Assistance for educational, professional, and clerical persons	300,000,000
Civilian Conservation Corps	600,000,000
Loans and grants to states, municipalities, etc., not less than 25 per cent of each loan or grant for work	900,000,000
Sanitation, prevention of soil erosion, prevention of stream pollution, sea coast erosion, reforestation, flood control, rivers and harbors, miscellaneous	350,000,000
Total	$4,000,000,000

A sum not to exceed 20 per cent of the $4,000,000,000 may be used to increase any one or more of the above items. This listing may be somewhat misleading in that it represents classes of work rather than functional divisions of the program. Any given item may be split between several operating agencies of the government.

General policies remain much as set in the President's first message to this Congress, giving preference to useful projects employing a high ratio of direct labor with some prospect of self-liquidation. Wages are to be more than doles but less than regular pay scales—the security wage idea. Competition with private industry is to be avoided. A shift of employables from cash relief into work relief projects will be undertaken as speedily as possible, focusing on the centers of unemployment, so that work relief will be raised from a present total of 2,500,000 persons to 3,500,000, while unemployables become the responsibility of the states. The hope is to carry through until private employment, stimulated perhaps by the indirect effects of the program, takes up the load. Above all, employment and social welfare are the main principles.

Activities of A.E.C. and Member Groups

Council membership is gaining under the new plan of nominal dues for state and local societies. In addition to those noted last month, the Arkansas Engineers' Club, the Cleveland Engineering Society, the Michigan Engineering Society, and the Providence Engineering Society have made definite application. The new plan of organization for the Council's regular and standing committees for 1935 has been completed. A report which outlines the functions of each committee and lists the personnel is available on request.

The new assistant secretary of the American Engineering Council is L. V. Reese, who was handling rural-industrial communities for the FERA before coming with the Council. Previously he was executive secretary of the District of Columbia Rehabilitation Corporation and was planning engineer of the Texas Relief Commission. He will serve as a liaison officer between the federal agencies and the member groups of the Council, and also will take charge of developing the Council's committee work, especially through the new system of public affairs committees designed to advance the position of organized engineers in public matters of moment to the profession. Mr. Reese, who is 43, was educated in civil engineering at the University of Texas and in mechanical, metallurgical, and industrial engineering at Columbia and New York universities.

Durable goods and housing was the subject of a round table conference in Washington April 30 at the annual meeting of the U. S. Chamber of Commerce, arranged through the suggestion of Alonzo J. Hammond, Past-President of the Society and Vice-President of the Council, who is a member of the Chamber's committee on relief activities, and with the cooperation of A. P. Greensfelder, M. Am. Soc. C.E., vice-chairman of the construction and civic development department committee of the Chamber.

Civil engineers in Washington held an informal dinner April 10 to welcome Walter E. Jessup, newly appointed Field Secretary of the Society, who was on an extended trip among Local Sections and Student Chapters. Prominent engineers attending included R. C. Marshall, Donald H. Sawyer, Arthur E. Morgan, George T. Seabury, Alonzo J. Hammond, and Herman Stabler, Members Am. Soc. C.E. A round table discussion followed the meeting.

Year Book for 1935 Distributed

By the time this issue of Civil Engineering is in the hands of the members, the *1935 Year Book*, published as Part II of the April Proceedings, will have been received. While the 1935 number follows the form used in 1934, the widespread changes in engineering organizations accompanying the present economic upheavals have necessitated a very large amount of revision in addresses.

The memberships of the various Society and Technical Division committees are in many cases not completed at the time set for the copy to go to the printer, and it is necessary to follow up such matters actively. However, the greatest difficulty arises from the fact that members frequently neglect to notify Society Headquarters of changes in address or of title. This year a post card was enclosed along with the bills for annual dues. Approximately 3,000 such postals were returned, calling for revisions in listings, exclusive of changes covered by letter memoranda and of postals returned indicating no change.

Work on a *Year Book* actually begins as soon as the preceding *Year Book* is off the press, which is early in April. Each page of the membership list is cut in half vertically and pasted on a large sheet to provide space for changes. These sheets are kept up to date by making revisions as fast as they are received at Headquarters. They are referred to as manuscript, and early in January are sent to the printer for a galley proof. Of course notifications of changes of address received after the manuscript has been set up in galley proof require costly changes. The lists are closed on March 1—the day on which galley proofs are forwarded to the printer to be made up into page proof, and no changes are made after that date so as to avoid the necessity for re-paging due to revisions which cannot be accommodated on individual pages. In order to ensure the accuracy of the data, galley proofs are checked against the names and addresses in the master files. An additional check is made by comparing the alphabetical and geographical lists in order to verify the locations of members and to see that the total number is the same in both lists.

The *1935 Year Book* shows a membership of 14,946, of whom 765 are resident outside of North America. There are 11,796 Corporate Members in the Society, who are entitled to hold office and to vote. According to the *Year Book* there are 3,046 Juniors, the latter having all the privileges of a Corporate Member except those mentioned. It is of interest to note the distribution of members in foreign countries: 63 in China, 31 in Japan, and 29 in India. In Australasia 52 are listed. The Fiji Islands, Samoan Islands, Abyssinia, Cyprus, and Iraq have one member each.

the California Institute of Technology in the Photo-Elastic Labora-

Virginia Conference of Student Chapters

A two-day conference of the four Student Chapters in Virginia was held in Lexington, Va., on April 5 and 6, 1935, with an attendance of about 175. The Chapters referred to are those at Virginia Military Institute, 87 members; Washington and Lee University, 16 members; Virginia Polytechnic Institute, 22 members; and the University of Virginia, 14 members. For this occasion the Virginia Military Institute cadets were hosts. Each visiting Chapter sent student delegates, and faculty advisers and contact members were present. President Tuttle and Secretary Seabury found it possible to be present by starting a few days earlier on their trip to Miami to attend the meeting of the Board of Direction of the Society. The Virginia Section of the Society, which sponsored the conference, was represented by the president, R. K. Compton, the secretary, P. A. Rice, and a group of members.

The meetings were held in Jackson Memorial Hall, beginning Friday morning. The opening address was made by Maj. Gen. John A. Lejune, retired commander of the U. S. Marine Corps and superintendent of the Virginia Military Institute. Secretary Seabury explained the organization of the Society, and President Tuttle spoke on Student Chapter activities. H. M. Waite, Vice-President of the Society in 1931 and 1932 and former deputy administrator of the Federal Emergency Administration of Public Works, and J. A. Anderson, M. Am. Soc. C.E., State Public Works Engineer for Virginia, also spoke. On Friday afternoon, papers were delivered on the physical and mechanical characteristics of soils and on public utilities. Afterward cadets of the Virginia Military Institute in formal uniform passed in review in regimental formation before the guests. A dinner and smoker was held Friday evening in the new mess hall at the Institute. Saturday morning was devoted to 13 addresses by the Student Chapter delegates, the proceedings being conducted by the various Chapter presidents.

The striking thing about the conference to the older members was the uniform excellence of the papers presented by the students and the ease and facility with which they were delivered. From the standpoint of all, the meeting was a great success and it was agreed by the Chapters to hold the conference again next year, with the Virginia Polytechnic Institute, at Blacksburg, and the Chapter there as hosts.

Research Problems in Hydraulics Available

A list of special problems in hydraulics was prepared and classified by the Society's Special Committee on Hydraulic Research, at a recent meeting held in Vicksburg, Miss. These problems are for the use of engineers and engineering students who wish to acquaint themselves with some of the phases of hydraulic research. They fall into three divisions: fairly simple problems for senior students; more difficult ones for those seeking postgraduate degrees; and still another group for those of high technical ability who are interested in the field of pure research. It is believed that the type of problem provided fills a very real need. Suggestions for other problems will be welcomed by the committee. The Chairman is J. C. Stevens, M. Am. Soc. C.E., 1202 Spalding Building, Portland, Ore.

Manual No. 8 as a Text

Since its distribution last fall, Manual No. 8, "Engineering and Contracting Procedure for Foundations," has been very favorably received and commented upon. Visualizing its further usefulness, one member suggested its value in undergraduate courses on foundation. Inquiry among a number of representative engineering teachers disclosed distinct possibilities for such use.

In order that this Manual may be of service to American engineering students, methods of facilitating its distribution have been considered. As a result, the Society is able to offer a reduction in price for quantity purchases. The present cost of the Manual is given as 40 cents, with a 50 per cent reduction for members, making the price 20 cents per copy. When ordered for student use in quantities of 20 or more, a special price of 15 cents per copy has now been set.

Defense of Two Members Under Way

Following closely on the decision of the Board of Direction last January that it would undertake the defense of members unjustly accused or deprived of position without proper hearing, two instances arose which could be considered as subject to the general instructions of the Board. That is, those cases appeared to have all the characteristics under which such defense efforts might be both practicable and desirable.

A state engineer of the Public Works Administration had been asked to tender his resignation, and an engineer formerly associated with him and practicing in that same state had been listed as one with whom the Public Works Administration would have no dealings. The instances were the subject of earnest consideration by the Local Section most intimately related to the situation, and by formal action were referred to the Board, with request for further action. The Vice-President of the Society representative of the Zone in which these two instances occurred, upon assignment undertook an investigation, devoting a total of seven days to a personal inquiry, visiting 11 cities, calling on many prominent engineers and respected citizens of the state, and interviewing affiants whose affidavits had been taken by a PWA special investigator. These affidavits, it appeared, had formed the foundation for the request for resignation of the one member and the listing of the other as unsatisfactory to the PWA.

An extensive report of the investigation was made to the Board of Direction at its Miami meeting, April 3, the report being accompanied by copies of the affidavits and by details of conversations with the affiants, and with others. The Board reached the conclusion that an injustice had been done both members.

The Board instructed the Secretary to advise the Administrator of the Federal Emergency Public Works Administration of its opinion that he had formed his conclusions on misleading information, with resulting injustice to the two engineers concerned. Further action of the Board, communicated to the Administrator, was a request that the cases be reopened and that when so reopened, representatives of the Board of Direction be permitted a hearing.

Field Secretary Visits Southern and Central Society Groups

As this issue goes to press Walter E. Jessup, newly appointed Field Secretary, is again making a trip among the Local Sections and Student Chapters. He left Headquarters on April 24, 1935, and will be away approximately a month, covering more or less the southeast and middle sections of the country east of the Mississippi River.

He is trying to fit his itinerary to dates which have already been fixed by various Local Sections for their meetings. On April 25 and 26 he was with the North Carolina Section at Durham, and with the Student Chapter at the University of North Carolina, at Chapel Hill. On Monday, April 29, he was with the Local Section at New Orleans and the Student Chapter at Tulane, next day making a visit to the Student Chapter at the University of Louisiana. On Thursday, Friday, and Saturday of that week, May 2, 3, and 4, he is to join the Texas Section at its semi-annual meeting at Corsicana, Tex. The following Monday and Tuesday, May 6 and 7, he is to be with the Local Section at Cincinnati, and with the Student Chapter at the University of Cincinnati, Cincinnati, Ohio.

On the following Wednesday, Thursday, and Friday, he will be successively with the Dayton Section, the Central Ohio Section at Columbus, and the Cleveland Section, making contact at Columbus with the University of Ohio Student Chapter and at Cleveland with the Student Chapter at the Case School of Engineering. Monday, May 13, is to be devoted to the Local Section at Toledo; Tuesday, May 14, to that at Detroit; Wednesday, May 15, to that at Indianapolis; and Friday, May 17, to the Mid-South Section at its meeting to be held in Little Rock, Ark. Following that meeting, he will return to New York in time to be present at the evening meeting to be held on May 20, when the governing boards of the Founder Societies are to gather at the Engineers' Club in New York to hear the details of the several joint activities participated in by these societies.

Viewed as a continuous journey, it is thus seen that Mr. Jessup's itinerary takes on the form of a somewhat distorted figure eight.

Additional Memoirs for Members and Friends

Appointments of Society Representatives

Preview of Proceedings

In May will appear the last number of PROCEEDINGS *before the summer interval of two months during which publication is suspended. The next succeeding, or August issue, will be mailed on August 15. The summer interval provides time for preparation of the next volume of* TRANSACTIONS.

Two new papers are in preparation for the May number of PROCEEDINGS: *one on the application of photo-elastic analysis, and the other on the shear-area method of analyzing beams. Several interesting closures of discussions will also appear in this issue.*

Photo-Elastic Determination of Shrinkage Stresses

A BRIEF and interesting treatment of the application of photo-elastic analysis is contained in a forthcoming paper on "Photo-Elastic Determination of Shrinkage Stresses" by Howard G. Smits, chief designing engineer for Oliver G. Bowen, M. Am. Soc. C.E., of Glendale, Calif. A model of a dam was cut from aluminum sheeting and a rubber diaphragm fixed between sections of the model in such a way as to define the principal stresses in the prototype. Since the model represents a purely theoretical condition, the results are of philosophical interest. According to Mr. Smits, nevertheless, they are of value to the designer in that points of high stress are indicated and the designer is given a general idea of the behavior of shrinkage stresses. Two isoclinic views are presented herewith to afford a rough demonstration of the nature of the results. The dark shadow in an isoclinic picture shows the region in which the inclination of the principal stresses is the same. In the left-hand view on this page the region is indicated where the directions of the principal stresses are parallel and perpendicular to the axis of the test piece. In the other view the principal stresses are inclined at angles (measured counterclockwise) of 3 deg and 93 deg with the axis of the test piece. The problem was studied at the California Institute of Technology in the Photo-Elastic Laboratory of the Guggenheim School for Aeronautics.

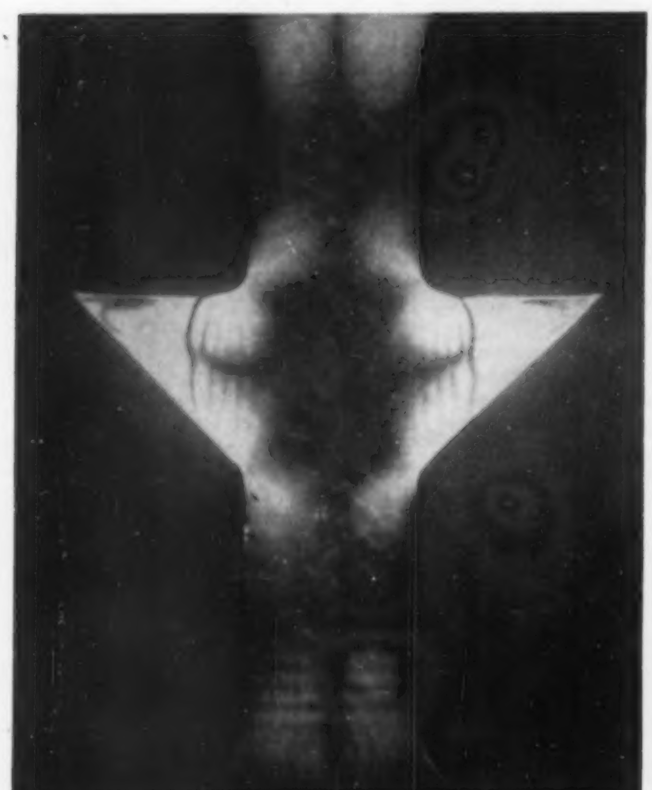
The Shear-Area Method

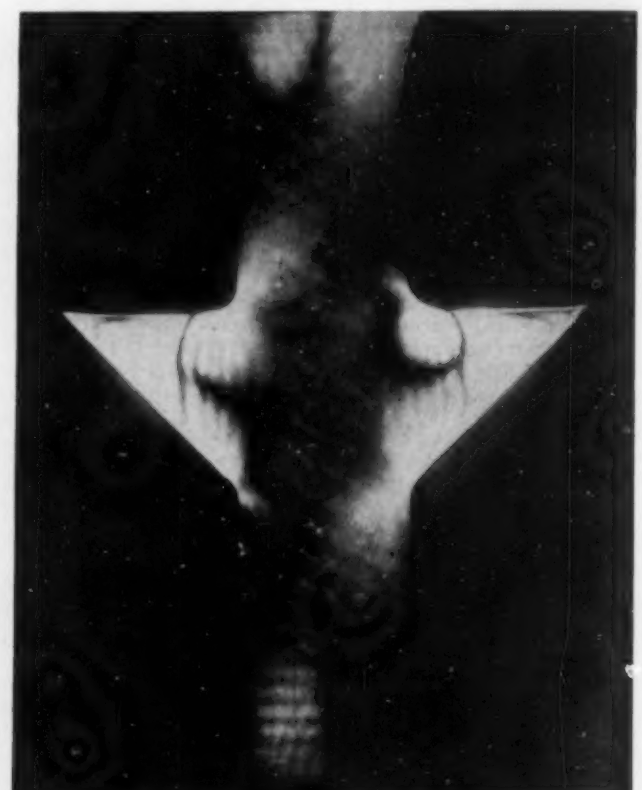
THE MOMENT-AREA method of analyzing beams is too well known to require extended comments. It will be interesting to review the theory, however, in the light of a paper by Horace B. Compton, Assoc. M. Am. Soc. C.E., and Clayton O. Dohrenwend, Jun. Am. Soc. C.E., entitled "The Shear-Area Method for the Determination of the Elastic Functions of Loaded Beams," which has been scheduled for the May issue of PROCEEDINGS. The authors advance a method of analyzing determinate and indeterminate structures in terms of hypothetical beams loaded with the shear diagram rather than the moment diagram.

Although the method described is based on well-known principles of mechanics, the method developed is novel and interesting. After a relatively brief general statement of the logic, the authors expand their subject into 22 hypothetical cases for various kinds of beams and conditions of loading.

Closing Discussion

IT IS to be noted that the closing discussions of a number of outstanding papers appeared in the April issue of PROCEEDINGS. Several others are scheduled for the May number. The papers on which closing discussions will be given are, notably, "Analysis of Sheet-Pile Bulkheads" by Paul Baumann, M. Am. Soc. C.E.; "Sand Mixtures and Sand Movements in Fluvial Models" by Hans Kramer, M. Am. Soc. C.E.; "Eccentric Riveted Connections" by Eugene A. Dubin, Esq.; "Determination of Trapezoidal Profiles for Retaining Walls," by A. J. S. Pippard, M. Am. Soc. C.E.; and "Laboratory Tests of Multiple-Span Reinforced Concrete Arch Bridges" by Wilbur M. Wilson, M. Am. Soc. C.E. In all 32 engineers have discussed these five papers during the past year. It is possible that one or two closing discussions may be published directly in TRANSACTIONS, without being previously printed in PROCEEDINGS. In a few cases this permits the publication of a completed paper in TRANSACTIONS an entire year before the normal time of such publication.





ISOCLINIC VIEWS SHOWING THE REGION IN WHICH THE INCLINATION OF THE PRINCIPAL STRESSES IS THE SAME

On the Left, the Principal Stresses Are Parallel and Perpendicular to the Axis of the Specimen. On the Right, the Stresses Are 3 Deg and 93 Deg with the Axis

Additional Memoirs for Members and Friends on Request

PREPRINT copies of a considerable number of memoirs are now available, on request, for interested members or their friends. These memoirs have been made available since the publication of Volume 99 of TRANSACTIONS in the fall of 1934. The preparation of these biographies is the product of the disinterested efforts of friends and associates of the deceased. The memoirs will appear of course in the next issue of TRANSACTIONS.

Requests for these preprints should be addressed to the Secretary at Headquarters. A list of the memoirs referred to follows.

Octavio Augusto Acevedo
Frederick Whitney Adgate
Kort Berle
Lyman Edgar Bishop
Wilbur Gayle Brown
James Parker Brownell
Morton Lewis Byers
Walter John Cahill
Henry Hall Carter
William Arnold Christian
Charles Samuel Churchill
John Adams Cole
Charles Francis Conn
Lorenzo Dana Cornish
Clyde Maxwell Cram
Benjamin John Curtis
William Clarence Davidson
Arthur Powell Davis
Frederick Eaton
Eric Gustaf Ericson
Frederic Morris Faude
Harry Jacob Finebaum
Walter Linder Foster
George Warren Fuller
Koi Furuichi
Elbert Allan Gibbs
Elmer Clark Goodwin
William Gore
John Francis Grady
William Albert Grover
Carl Ewald Grunsky
Thomas Chalkley Hatton
John Edward Hill
George Waldo Hillman
Elmer Guy Hooper
John Jay Lafayette Houston
George Edward Howe
John Alexander Jameson, Jr.
George Arthur Johnson
Maurice Edwin Kernot
Alfred Watts Kiddle
Warren Raymond King
Isaac Henry Kirby
Victor Hugo Kriegshaber
Oliver Howard Lang
James Brownson McClain
James Robinson McClintock
Patrick McGovern
Arthur Sawyer Mahoney
Thomas Vincent Moore
Floyd August Nagler
Lars Netland
Maury Nicholson
Emil Louis Nuebling
John Francis O'Rourke
Michael Maurice O'Shaughnessy
George Abel Pierce
Henry Sewall Prichard
Herbert Allan Rice
Clarence Mord Rogers
Hiram Abif Schofield
Edson Oliver Sessions
George Harry Thornton Shaw
Joseph Mansfield Slater
Kenneth Irving Small
Theodore Speiden
Gustave Arnold Stierlin
Burtis Paul Thomas
Aaron Howell Van Cleve
Alexander Wilson Vars
Herman Greig Veeder, Jr.
John Douglas Waldrop
Edwin John Weigand

Obtaining Photoprints from the Library

IN A five-year period the Service Bureau of the Engineering Societies Library has supplied almost 200,000 photoprints of material in the Library to individual engineers, engineering corporations, and libraries throughout the world. This service makes it possible for an engineer to obtain copies of articles or of books which he needs in his work when he is far removed from a library, or when his local library cannot provide the technical information desired. This can generally be found in the great wealth of engineering information housed in the Engineering Societies Library.

Photoprinting makes it possible for the Service Bureau to supply exact copies of printed or manuscript data, graphs, charts, maps, and illustrations at a minimum cost. Pages may be photographed just as they appear in the book or, in the case of a small print, they may be enlarged for increased clarity and ease in reading. Photostats are sent either as negatives, that is, white printing on a black background, or as positives, that is, black printing on a white background. However, the cost of a positive print is twice that of a negative because the negative must always be made first.

Photoprinting, as well as searching, abstracting, translating, preparing of bibliographies, and all other work is done by the Service Bureau at cost. For further information or quotations, inquiries should be addressed by mail, telephone, or telegraph to the Engineering Societies Library, 29 West 39th Street, New York, N.Y.

Appointments of Society Representatives

ALBERT S. CRANE, M. Am. Soc. C.E., will represent the Society on the Hoover Medal Board of Award for the six-year term, October 1934–to October 1940.

EUGENE L. MACDONALD and L. G. HOLLERAN, Members Am. Soc. C.E., will serve, respectively, as representative and alternate on the Council of the American Standards Association.

MALCOLM PIRNIE, M. Am. Soc. C.E., has accepted an appointment as Society representative on the Durable Goods Industries Council.

EDMUND A. PRENTIS, M. Am. Soc. C.E., will serve as Society representative on the Board of Directors of the American Standards Association.

News of Local Sections

BUFFALO SECTION

On March 12, the Buffalo Section held a meeting at which George Minnis, chief engineer of the Buffalo Grade Crossing Commission, gave an interesting talk on the early stages of the development of grade crossings in Buffalo. At a meeting held on March 21, S. C. Hollister, director of the School of Civil Engineering of Cornell University, spoke on the engineering activities at that university. The annual elections were held on April 2, at which time the following officers were chosen for the coming year: Arthur Skaer, president; William P. Feeley, vice-president; and Stewart S. Neff, secretary-treasurer.

CENTRAL ILLINOIS SECTION

A special dinner meeting of the Central Illinois Section was held at Champaign, Ill., on March 22 in honor of H. M. Westergaard, Professor of Theoretical and Applied Mechanics at the University of Illinois, and most recent recipient of the Society's J. James R. Croes Medal. Speeches were made by Arthur C. Willard, president of the university; Hardy Cross, of the Department of Civil Engineering, Dean Carmichael, of the Graduate School; and E. L. Erickson, head of the Department of Engineering Mechanics of the University of Michigan. The total attendance, which was 81, included representatives from the University of Michigan, Purdue University, and the Illinois Section. On February 14 a business meeting of the Section was held with 20 members and guests in attendance.

CENTRAL OHIO SECTION

There were 20 in attendance at a meeting of the Central Ohio Section held on February 14. Several business matters were discussed, and D. B. Steinman, president of the National Society of Professional Engineers, described the recent activities of the society.

CINCINNATI SECTION

A joint meeting of the Cincinnati Section and the University of Cincinnati Student Chapter was held on April 1. After a discussion of various business matters the speaker of the evening, J. E. Root, Director of the Department of Public Works, City of Cincinnati, was introduced. The subject of his discussion was proposed local improvements that will soon be undertaken by the department. There were 60 members and guests present.

CLEVELAND SECTION

The Cleveland Section held a meeting on March 5 at the Chamber of Commerce Club. The speaker of the occasion was George B. Gascoigne, who gave an outline of Cleveland's sewage treatment program that elicited much enthusiastic discussion. During the business session several committee reports were read.

ITEMS OF INTEREST

Colorado Section

At a meeting of the Colorado Section, held on February 12 at the Olin Hotel, A. K. Vickery, city engineer, C. A. Davis, and F. C. Carstarphen discussed the Cherry Creek flood-detention reservoir. At the meeting of March 11, the Section heard L. W. Hamilton, J. N. Bradley, and I. K. Silverman speak on laboratory apparatus, hydraulic models, and photo-elasticity.

The Junior Association of the Section held meetings on January 28 and February 25. At the former, the subject of radio broadcasting in its human and technical aspects was discussed by Clarence C. Moore and Robert Owen of the KOA broadcasting station. In connection with this, an inspection trip was made to the KOA studios on February 2. At the latter meeting Sam Evans, of the Gates Rubber Company, described some aspects of the manufacture and sale of tires.

Dayton Section

The March meeting of the Dayton Section, which was held on March 18, took the form of a combination luncheon and inspection trip. After luncheon at the Engineers Club the members were afforded an opportunity to witness the production of rubber automobile accessories and other products by the Inland Manufacturing Company and to inspect a new office-warehouse recently completed for the company.

Kansas City Section

The Kansas City Section held a meeting on March 20 at the University Club. At this session H. C. Hunter, erecting manager of the American Bridge Company, gave an illustrated talk on the San Francisco–Oakland Bay Bridge and answered various questions from his audience on the subject. There were 55 members and guests present.

Kansas State Section

A meeting of the Kansas State Section was held on March 11 at the Hotel Kansan in Topeka. The feature of the evening was an address by Henry E. Riggs on recent actions of the Board of Direction of the Society. There were 42 members and guests in attendance.

Metropolitan Section

On April 17 the Metropolitan Section held an interesting meeting in the Engineering Societies Building, New York, N.Y., attended by 275 members and guests. George T. Seabury, Secretary of the Society, outlined briefly its numerous activities and recent accomplishments in connection with public work and in improving the engineer's professional status. After certain resolutions had been read and some announcements made, the finals of the Juniors' speaking contest were held. The prize of $15 for the best address went to George L. Curtis, who spoke on unemployment insurance. The principal address of the evening was made by Ole Singstad, president of the Metropolitan Section, who gave an illustrated talk on the tunnels under the Scheldt River at Antwerp and under the Mersey River at Liverpool. Refreshments were served after the meeting.

Milwaukee Section

Several business matters were discussed at a meeting of the Milwaukee Section held at the City Club on March 18. Then Walter E. Jessup, newly appointed Field Secretary of the Society, who is establishing contact with the various Local Sections, gave a talk on several topics of interest to the Section. One of the interesting features of the occasion was the showing of two motion pictures on engineering subjects by B. E. Brevick.

New Mexico Section

The New Mexico Section held a meeting on February 13 at Albuquerque, at which Paul S. Fox, state sanitary engineer, spoke on the modern trend in sewage disposal plants. On March 13, the section held a meeting at which H. C. Neuffer read an interesting paper on the construction code for dams as applied in the states of Arizona and California. An educational motion picture was also shown depicting the construction of a steel pipe line. On December 19, 1934, E. L. Barrows was elected president for 1935, the other officers holding over from the previous term.

Northwestern Section

On March 20, the Northwestern Section held a meeting at the Campus Club of the University of Minnesota. About 65 members and guests were present and heard an interesting address by Lazarus White on the application of modern theories of soil mechanics to design and construction.

Philadelphia Section

On February 23 the Philadelphia Section celebrated the twenty-first anniversary of its founding with a dinner at the Engineers Club. The attendance was unusually large, and the guests of honor were Arthur S. Tuttle, President of the Society, and George T. Seabury, Secretary. Four of the six surviving charter members of the Section, namely, William Easby, Jr., Benjamin Franklin, Harrison W. Latta, and Henry H. Quimby, were called forward and congratulated. The party later adjourned to the indoor "circus grounds" and witnessed a number of amusing acts. Dancing and cards followed until a late hour. Lyle L. Jenne, as chairman, arranged the entire program.

Portland (Ore.) Section

A meeting of the Portland (Ore.) Section was held on February 26 in the club rooms of the Chamber of Commerce. Fred Merryfield, professor at Oregon State College, spoke on "Engineering Comments on Europe," describing conditions in various European countries that he has visited recently, and a general discussion followed. There were 23 members present.

Providence Section

On March 21 a meeting of the Providence Section was held at the Providence Engineering Society Building. The speaker of the occasion was Leslie A. Hoffman, State Engineer for Connecticut and Rhode Island of the Federal Public Works Administration, who chose for his topic, "A Résumé of PWA Activities Since Its Inception."

St. Louis Section

The St. Louis Section held a meeting on March 25 at the Roosevelt Hotel. At this session Harvey J. Howard gave an interesting résumé of his experiences in China. This was followed by a brief talk by Walter E. Jessup, recently appointed Field Secretary of the Society. There were 50 members and guests present, including a number of juniors.

San Diego Section

The February meeting of the San Diego Section was held at the Golden Lion Tavern on February 28. The feature of the occasion was a talk by J. T. Towers, commanding officer of the Naval Air Station, who spoke on the history of naval aviation and showed the great amount of research and experimentation that has made modern aviation possible.

Student Chapter News

Johns Hopkins University

On February 14 the Johns Hopkins University Student Chapter held a dinner meeting in Levering Hall on the campus of the university. After dinner Guy L. Bryan, Jr., of the Stress Analysis Department of the Glenn L. Martin Company, spoke on typical methods of design in aeronautics.

Lewis Institute

A special meeting of the Lewis Institute Student Chapter was held on March 1. R. A. Kirkpatrick gave a lecture on the "Geology of the Canyon National Parks," and illustrated it with natural color photographs that he has taken during the past year. There were 800 students present.

Rhode Island State College

At a meeting on February 25, the Rhode Island State College Student Chapter heard an interesting talk by Irving W. Patterson, of the Lane Construction Company, concerning his 35 year's experience in the building of highways. The meeting was attended by 27 members and guests.

ITEMS OF INTEREST

Engineering Events in Brief

Civil Engineering for June

Among the articles scheduled for the June number of Civil Engineering is one by Frank E. Bonner, M. Am. Soc. C.E., consulting engineer of Piedmont, Calif., in which he describes recent studies of precipitation in the Pacific states. The object of these studies was to find some correlation between rainfall, tree growth, and sun spots in an effort to predict future precipitation. He comes to the conclusion that precipitation in the past can be interpreted from the "unique language of the trees with a margin of error slightly better than that afforded by the toss of a coin" and that sun-spot numbers are about equally useful. Nevertheless, from a study of sequoia growth, he reaches the positive conclusion that the California climate has been remarkably stable during the last twenty centuries.

Of interest in the field of hydraulic experimentation is the article on the glass-sided tilting flume recently constructed at the U. S. Waterways Experiment Station at Vicksburg, Miss., for the purpose of studying the movement of bed load; the progression of riffle formations; the building of bars and erosion of banks; and the effects of turbulence, eddies, and rollers. The co-authors, Carl E. Bentzel and Joseph B. Tiffany, Jr., Jun. Am. Soc. C.E., both research assistants at the experiment station, explain the construction and use of the flume and the mechanism for changing its slope. Although the use of glass sides is no innovation, this flume is unique in that it is equipped both with glass sides and with a single tilting mechanism. Only one other flume, that in Stockholm, Sweden, has both glass sides and a tilting mechanism, but its slope must be regulated by individua manipulations of the screws at the mid- and end-points.

Another article by Walker R. Young, M. Am. Soc. C.E., on the subject of Boulder Dam is scheduled for the June number. In his current paper he records the basic needs for the work and the legislative difficulties encountered in getting it under way. In the forthcoming article, entitled "Mission of Boulder Dam Fulfilled," he discusses the advantages to be secured as a result of the work in relieving unemployment, removing flood menace, supplying water for irrigation and domestic use, controlling silt, improving navigation, and developing power. In addition there is being established a new recreational area for nature lovers and sportsmen.

Of considerable general interest will be the article on highway construction in Colombia, South America, by Albert A. Mittag, Assoc. M. Am. Soc. C.E. It will be illustrated with views of some of the extremely rugged terrain encountered by the road builders, who were forced to rely almost entirely on hand labor. There have been only five road projects of any magnitude in Colombia in the past seven years. Mr. Mittag deals with two of these, the Carretera-al-Mar and the Bucaramanga-Mortiño. The first connects Medellin, the capital of the Department of Antioquia, with the Gulf of Uraba and so with the Caribbean Sea, a distance of about 300 km. The second, only about 55 km long, connects Bucaramanga with the main route already constructed between Bogota and Cucuta. Bucaramanga is the capital of the Department of Santander del Norte and the center of a rich agricultural and tobacco-growing district. Methods and details of construction are discussed in their relationship to living and labor conditions. Mr. Mittag also discusses the projected Pan-American Highway as it relates to Colombia's road problem.

Convention Visit to Windsor Castle

On the occasion of the Society's Thirty-second Annual Convention, held in London, England, in July 1900, a group of members visited Windsor Castle. An interesting account of this visit appears in newspaper clippings of the time, supplied by A. E. Kornfeld, Affiliate Am. Soc. C.E. The party, about 250 in number, traveled from Paddington Station by a special train on the Great Western to Windsor.

The report goes on to say that members of the party were served tea and light refreshments in the orangery and afterward proceeded to the south side of Windsor Castle, there to await the arrival of Queen Victoria. John F. Wallace, President of the Society, and others were presented and it is recorded that three hearty "American cheers" were given for the Queen, who expressed herself as being happy to see them and hoping that they had been made comfortable. The following evening they were received in traditional style at the London Guildhall by the Lord Mayor and Corporation.

Article on Beam Deflections Translated Into Chinese

An article on an "Improved Method of Finding Beam Deflections" by Ralph W. Stewart, M. Am. Soc. C.E., appearing in the February 1934 issue of Civil Engineering, has been translated into Chinese, according to information furnished by Fang-Yin Tsai, Assoc. M. Am. Soc. C.E., Professor of Civil Engineering at the National Tsing Hua University in Peiping. After being translated by two of Professor Tsai's students, it was published in the engineering journal of the university. This is a matter of considerable gratification, not only to the Society in whose publication this noteworthy paper was presented, and to the author whose work has been so esteemed, but to the Chinese engineers who were quick to discover the value of a new method of solution for a type of problem frequently encountered.

An Early Automobile

One of the earliest automobiles was built and operated in Philadelphia in 1804, the product of the vision and mechanical ability of one Oliver Evans, a former wheelwright's apprentice. Evans had been commissioned to construct a steam-propelled flat boat to be used in cleaning the city docks.

To avoid the use of horses the inventor had geared the five-horsepower steam engine to the wheels of the wagon on which the barge was being transported westward to the Schuylkill River. The operation of the queer contrivance was clumsy and extremely slow and it was soon surrounded by a crowd whose astonishment quickly changed to contempt. Laughter and cat calls arose on all sides and loud advice was given to "Get a horse." The story goes that Evans jumped to the ground with a bag containing the $3,000 which he had just been paid for the construction of the barge. Brandishing the money in his hand he offered to wager that he could build a steam carriage capable of outdistancing any horse over a five-mile course on the Lancaster Pike.

There was much loud talk among the onlookers but no one offered to take the bet, so Evans remounted his juggernaut and proceeded westward to the river. After installing a paddle wheel and launching the strange craft, the inventor calmly took the controls and steamed away down the Schuylkill.

Memorial to J. Waldo Smith

A triangulation tower on an Ashokan hilltop in view of the reservoir and aerator of the Catskill water supply system will be reconstructed as a memorial to the late J. Waldo Smith, Honorary Member of the Society and former chief engineer of the Board of Water Supply of New York City. The tower is 40 ft high and 30 ft square, and its location is well chosen to commemorate the builder of the water system. The estimated cost of $5,000 will be defrayed through subscriptions by Mr. Smith's numerous friends.

The chairman of the Memorial Committee is Thaddeus Merriman, M. Am. Soc. C.E., who succeeded Mr. Smith as chief engineer. A brief memoir and glowing tribute to Mr. Smith by Mr. Merriman appeared in the November 1933 issue of Civil Engineering.

Engineering Fallacies More or Less Common

By ROBINS FLEMING
AMERICAN BRIDGE COMPANY, NEW YORK, N.Y.

A NUMBER of fallacies dealing with problems of design are more or less current among engineers. Eight of the more striking of these are included here, together with an explanation of what is felt to be the true solution, reinforced in many cases by references to standard works.

A quite general opinion exists that beams weak in horizontal shear can be strengthened by adding material beyond the supports. There is no theoretical basis for such an assumption. A series of experiments is described in the article, "The Compressive Strength of Short Wooden Beams with and Without Overhang Beyond the Supports," by F. J. Converse, Assoc. M. Am. Soc. C.E., of the California Institute of Technology, in *Proceedings* of the American Society for Testing Materials, Vol. 30 (1930), Part II, page 1006. Mr. Converse is led to conclude: "Extending beams beyond the support is of no value in preventing failure by longitudinal shear in beams in which there is no crushing under the loads or over the supports."

The moment area method of determining the deflection of loaded beams is usually considered a single integration method. This is not strictly correct. The following statement of the case is taken from Professor Boyd's *Strength of Materials*. The familiar formula,

$$M = EI\frac{d^2y}{dx^2}, \text{ may be written}$$

$$y = \iint \frac{d^2y}{dx^2}\,dx\,dx = \int \frac{M}{EI}\left(\int_{x_1}^{x} dx\right)dx$$

$$= \int \frac{M}{EI}\left(x\right)_{x_1}^{x}$$

$$y = \int \frac{M}{EI}(x - x_1)\,dx$$

The dx under the parenthesis is integrated first, and then, after substituting the limits (one of which is the constant x_1 and the other is the variable x), this is combined with the remaining term for the second integration. Then if x_1 is zero,

$$y = \int \frac{M}{EI}\,x\,dx$$

Again and again the question is asked with what "force" does a falling body strike another body. The term is a misnomer. As Kent says in his *Mechanical Engineers' Pocket Book*, this question "is based upon a misconception or ignorance of fundamental mechanical laws. The energy or capacity of doing work of a body raised to a given height, and let fall, cannot be expressed in pounds, simply, but in foot-pounds."

Another misnomer is the term "centrifugal (center-fleeing) force." This is not a force at all; but the term is deeply rooted in our language. It is the reaction of the centripetal (center-seeking) force and may be defined as the resistance which the inertia of a body in motion opposes to whatever deflects it from the rectilinear path. A common fallacy is that mud or other matter flies off radially from a rotating wheel or that a weight, if tied to the end of a string and swung around in a horizontal circle, tends to move off radially in a direction in line with the string. The fact is that both the mud from the wheel and the weight from the string tend to move tangentially and not radially.

It is sometimes assumed that in a beam the relative strength of the material in tension and compression depends upon the location of the neutral axis, or that the moment of the horizontal forces on one side of the neutral axis is equal to the moment of those on the other. That this is a false theory of flexure is pointed out in Goodman's *Mechanics Applied to Engineering*, Merriman's *Mechanics of Materials*, and other works. Quoting from the former: "As the tensions and compressions form a couple, the total amount of tension is equal to the total amount of compression; therefore the area of the figure above the neutral axis must be equal to the figure below the neutral axis, whether the section be symmetrical or otherwise; but the moment of the tension is not equal to the moment of the compression about the neutral axis in unsymmetrical sections."

From his book, *Columns*, E. H. Salmon is widely known as an authority on the subject. In his paper, "Column Fallacies," read before the Institution of Structural Engineers, February 21, 1924, and printed in the March 1924 issue of *The Structural Engineer*, he lists 18 fallacies and states his reasons for considering them as such. Eight of these fallacies are here quoted:

"That the defect in Euler's formula is the neglect of the direct compressive stress."

"That the deflection of an ideal column is an indefinite function of the load."

"That it is possible to prove the Rankine-Gordon formula theoretically."

"That a 'straight-line formula' is the simplest column formula."

"That eccentricity of loading is the principal source of weakness in columns."

"That there is a tension side in the ordinary practical column."

"That in built-up columns the moment of inertia about the two principal axes should be the same."

"That batten plate columns are unscientific in design."

A common fallacy among amateurs in engineering concerns the term "accuracy." Now accuracy is a relative term. Professor Tracy in his *Plane Surveying* pertinently writes: "A result cannot be more accurate than the data from which it is obtained. . . . The position of the decimal point has nothing to do with the relative precision of a measurement, and the mistaken idea that the number of decimal places to which a result is carried indicates the accuracy of that result is responsible for a great deal of stupid and unnecessary labor."

"The more you load a light bridge the stiffer it becomes," was the oft-repeated statement of a highway bridge agent of fifty years ago. Unfortunately he induced some town officials to believe it. Most contractors could give fallacies common with purchasers: that no charge will be made for "extras" in a contract; that specifications mean what they say; that the lowest tender is the cheapest; and a score of others.

Back Copies of "Engineering News-Record" Available

SIX VOLUMES of *Engineering News-Record* for the years 1929 to 1934 inclusive are available for the use of any engineering college, Local Section, Student Chapter, or individual member free of charge except for shipping cost. The issues are unbound. Requests should be addressed to the Secretary of the Society, who will put the inquirer in touch with the owner.

American Water Works Association Elects Officers

A RECENT announcement of the American Water Works Association names the new president and treasurer for the 1935–1936 term. These are, respectively, Frank A. Barbour and William W. Brush, both Members Am. Soc. C.E.

National Leveling Net Nearing Completion

A HUGE net of accurate leveling, with meshes spaced about 25 miles apart over the 3,000,000 sq miles of the United States, will be practically finished by July 1, 1935, according to R. S. Patton, M. Am. Soc. C.E., Director of the U. S. Coast and Geodetic Survey of the Department of Commerce. Lines will not be run of course in a few inaccessible mountain areas, now without roads or trails, unless demands for them are more urgent than at present. This leveling furnishes the accurate elevations above sea level of tens of thousands of bench marks, each an inscribed metal tablet set into a building, in outcropping rock, or in a special block of concrete, in such a way as to ensure permanency.

During January, 12,353 miles of accurate leveling were added to the national net, and during February, 10,228 miles. The combined distance leveled over during these two months alone nearly equals the circumference of the earth, about 25,000 miles.

Leveling furnishes vitally important information for reforestation studies, in combating soil erosion, and in planning irrigation, and is essential to the making of topographic maps showing exact and scientific delineations and descriptions of any region in minute detail. The local engineer starts his lines of levels from one of the bench marks of the U. S. Coast and Geodetic Survey, near at hand.

There are now 76 leveling units in the

field, whereas five years ago there were only from 6 to 8. This great expansion in the leveling operations of the U. S. Coast and Geodetic Survey, involving the completion of more than 215,000 miles of lines, has been brought about through the allotment of public works funds and has made possible the engagement of many unemployed engineers and surveyors. Candidates for chief of party were given intensive training in the use of instruments and methods of accurate leveling. They were then given charge of a leveling unit under the direction of one of the regular Bureau engineers, and turned in excellent results.

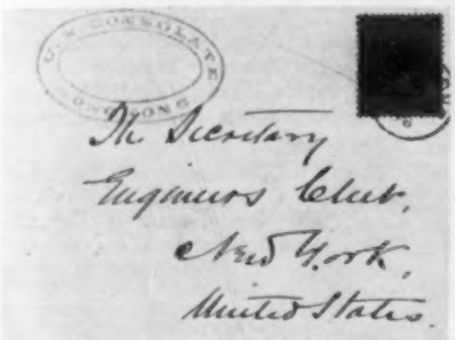
Should topographic mapping be undertaken in any part of the country, additional leveling would be required, but this could be supplied promptly as it is merely a matter of going into the 25-mile meshes of the fundamental net and running additional lines of levels with a spacing of approximately 6 miles. If notice is given a few months in advance of the needs of the topographic engineer, the additional leveling can be completed before the topographic surveying begins.

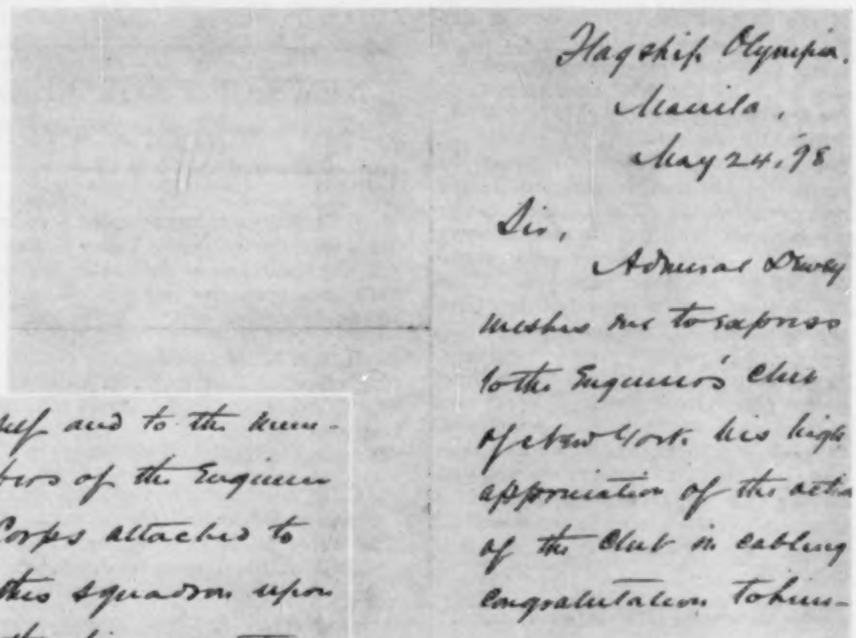
Echo of the Spanish War

AN INTERESTING reminder of the Spanish-American War has come to light through receipt at Society Headquarters of a letter from Alfred A. Stuart, M. Am. Soc. C. E., Winter Park, Fla. Mr. Stuart enclosed the original letter dated May 24, 1898, by T. M. Brumby, Dewey's flag lieutenant at Manila Bay, acknowledging receipt of a message from the Engineers' Club of New York congratulating Commodore (later Admiral) Dewey on his conduct of the recent action. A reproduction of the letter from Lieutenant Brumby appears here. Mr. Stuart came upon this document among some old personal letters. In accordance with his wishes it has been turned over to the Engineers' Club. The following description of the battle, fought with a plucky adversary, gallant but equipped in an inferior way, is taken from the account in the *Encyclopædia Brittanica*.

"In the Pacific, the American squadron—the protected cruisers *Olympia* (flagship of Commodore George Dewey), *Baltimore*, *Raleigh*, and *Boston*, the small unprotected cruisher *Concord*, the gunboat *Petrel*, the armed revenue cutter *Hugh M'Mulloch*, with a purchased collier, *Nanshan*, and a purchased supply ship, *Zafiro*, left Hongkong at the request of the governor and went to Mirs Bay, some miles east of the Chinese coast. Ordered (April 25) to begin operations, particularly against the Spanish fleet, which he was directed to capture or destroy, Dewey left Mirs Bay on the 27th, and arrived off Luzon, in the Philippines, on April 30. The Spanish admiral Montojo anchored to the eastward of the spit on which are the village and arsenal of Cavite, in a general east and west line, keeping his broadside to the northward. His force consisted of the *Reina Cristina*, the *Castilla* (an old wooden steamer which had to be towed), the *Isla de Cuba* and *Isla de Luzon* (protected cruisers of 1,050 tons), the *Don Juan de Austria* and the *Don Antonio de Ulloa* (gunboats of about 1,150 tons) and the *Marques del Duero* (of 500 tons).

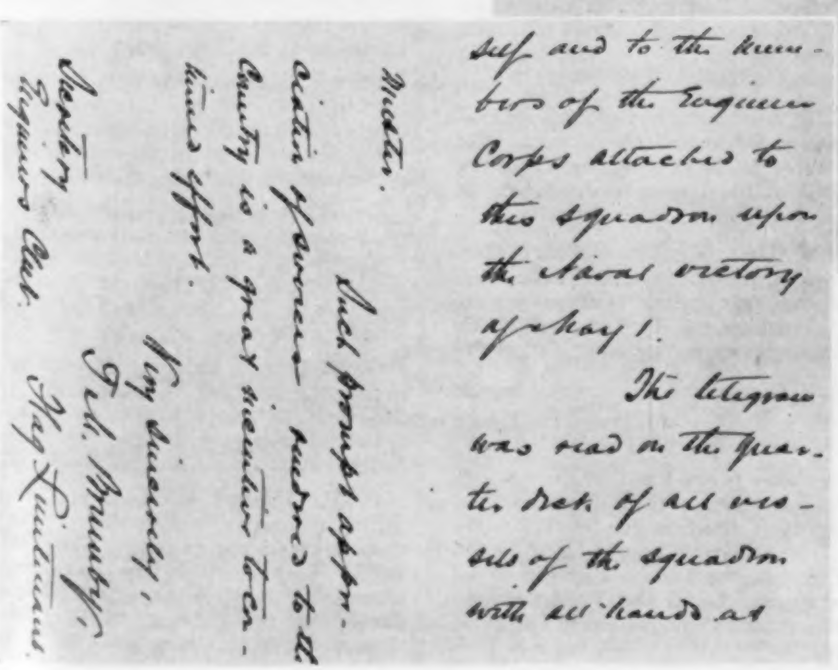
"Dewey passed into the Boca Grande, paying no attention to rumors of torpedoes, and at midnight passed El Fraile. When he sighted the Spanish squadron to the southward he stood down in column with the *Olympia*, *Baltimore*, *Raleigh*, *Petrel*, *Concord*, and *Boston*, at 400-yd intervals. When within 5,000 yd he ported his helm and at 5:41 a.m. opened fire. He stood westwards along the Spanish line, using his port batteries, turned to starboard and stood back, gradually decreasing his distance to 2,000 yd. At 7:35 Dewey withdrew and gave his men breakfast. Before he reengaged at 11:16 the *Cristina* and *Castilla* had broken into flames, so that the remainder of the action consisted in silencing the Cavite batteries and completing the destruction of the smaller Spanish ships. The victory was complete. All the Spanish ships were sunk or destroyed. The injury done the American ships was practically nil. The Spanish lost 167 killed and 214 wounded, out of a total of 1,875. The Americans had 7 slightly wounded out of 1,748 men in action. Dewey took possession of Cavite and awaited the arrival of a land force to capture Manila."


The Secretary
Engineers Club,
New York,
United States.


Flagship Olympia,
Manila,
May 24, 98.

Sir,

Admiral Dewey wishes me to express to the Engineers' Club of New York his high appreciation of the action of the Club in cabling congratulations to him-


self and to the members of the Engineer Corps attached to this squadron upon the Naval victory of May 1.

The telegram was read on the quarter deck of all vessels of the squadron with all hands at muster.

Such prompt appreciation of services rendered to the Country is a great incentive to enhanced effort.

Very sincerely,
T. M. Brumby,
Flag Lieutenant.

Secretary
Engineers Club.

How Engineers React to Unemployment

A STUDY of the effect of unemployment upon the viewpoint of professional engineers was made by the Engineering Foundation and the Personnel Research Federation some time ago but the results are just as interesting today as at the time of the survey.

The study revealed the extent to which work relief preserves morale and other mental attitudes. The morale of men on work relief had fallen only five-eights as far as that of men, who, although in similarly desperate financial straits, had not received such relief. Men on work relief were also less bitter toward employers as a class and were less critical of the existing political and economic systems.

The attitudes of about one thousand engineers divided equally into groups of comparable status representing the unemployed and the employed were studied. Each engineer was asked to agree or disagree with 57 statements or controversial topics.

The opinions of unemployed and employed men on some of the specific topics, with the percentage of each group in agreement, follows: "Industry's contribution to unemployment relief is mainly an attempt to keep unemployed men from stirring up trouble," 55 per cent of the unemployed, 37 per cent of employed. "Industry should be forced to make provisions for unemployment insurance," 75 per cent unemployed, 63 per cent employed.

"Ambition is all right for youngsters, but a man gets to realize it is all the bunk," 19 per cent unemployed, 11 per cent employed. "The United States comes closer to being an ideal country than any other," 56 per cent unemployed, 61 per cent employed. "The Communists may be noisy but they have the right idea," 15 per cent unemployed, 8 per cent employed.

"There is no justification for a strong radical party in this country," 50 per cent unemployed, 60 per cent employed. "Success is more dependent on luck than on real ability," 49 per cent unemployed, 29 per cent employed. "Religion is a comfortable haven in an insecure world," 55 per cent unemployed, 63 per cent employed.

"Our form of government, while imperfect, is the best in the world today," 45 per cent unemployed, 49 per cent employed. "There is little chance for advancement in industry and business unless a man has unfair pull," 49 per cent unemployed, 20 per cent employed. "During the depression the great majority of employers have acted fairly," 40 per cent unemployed, 59 per cent employed.

"It is industry's idea to drive you as hard as it can and give you as little as possible," 58 per cent unemployed, 39 per cent employed. "It doesn't pay to work too hard, because employers will only take advantage of you," 28 per cent unemployed, 9.7 per cent employed.

"Unemployed men between the ages of 31 and 40 show the greatest antagonism toward employers as a class," the report says. "Below 30 years of age the unemployed do not differ greatly from the employed men in their attitude toward employers. The greatest difference between groups occurs in the 31- to 40-year interval; the difference remains fairly large through the remainder of the age range. Accepting the employed group as a fairly normal one, it may be concluded that under ordinary conditions as they grow older, men become more favorable toward employers. More strictly, with the sample of employed men here studied, the older the men, the more favorable were their attitudes toward employers.

"The younger unemployed men have the highest or best occupational morale. As with attitude toward employers, the peak of disaffection is found among those from 31 to 40 years old. With increasing age morale improves, at least up to 60, but never becomes as good as with the men between 21 and 30. Over 60, there is a slight turn in the curve toward lower morale.

"In the groups studied, attitude toward religion changes very little from 21 to 40, but from that age on there is evidence of increased favorableness toward religion. From 21 to 40 the employed men are slightly more favorable toward religion than the unemployed, while from 41 to 60 the reverse is true."

NEWS OF ENGINEERS

From Correspondence and Society Files

J. H. KIMBALL has accepted a connection with the Tennessee Valley Authority in the capacity of hydraulic engineer. His headquarters are in Knoxville, Tenn.

H. RAY KINGSLEY, formerly commanding officer of Company 756, CCC Camp DPE-216, is now employed as a structural engineer at the Federal Warehouse in Washington, D.C.

C. B. NOLTE has tendered his resignation as president and general manager of the Robert W. Hunt Company, Engineers, of Chicago, Ill., to accept the presidency of the Crane Company of the same city.

H. W. ENGLISH has severed his connection with the Trinityfarm Construction Company, of Dallas, Tex., to become senior engineer for the Tennessee Valley Authority in Corinth, Miss.

E. E. GARNETT, JR., is now an assistant engineer in the National Park Service, with offices in San Francisco, Calif.

HERBERT JAMES KING, in the capacity of superintendent of the L. E. Dixon Company, Bent Brothers Inc., and Johnson Inc., is employed on the construction of the Pasadena Tunnel, a project of the Metropolitan Water District of Southern California, with headquarters in Pasadena, Calif.

JAMES S. CLEMENTS, formerly a rodman with the G. C. and S. F. Railway, is now employed as an instrumentman in the Texas State Highway Department. His headquarters are in San Antonio, Tex.

NELSON TAYLOR and ARTHUR TAYLOR, for many years members of the firm of Salisbury, Bradshaw and Taylor, of Los Angeles, Calif., announce the formation of the firm of Taylor and Taylor, consulting engineers, with offices at 725 South Spring Street, in the same city.

E. A. BLANPIED is now safety engineer for the Kansas City Bridge Company, of Kansas City, Mo.

H. S. GIBBONEY has resigned as district manager of the National Steel Fabric Company, of Atlanta, Ga., to become district sales manager of the Pittsburgh Steel Company, with headquarters in the same city.

CARL E. JOHNSON has accepted an appointment as inspector in the U. S. Army, Corps of Engineers, and is located in the U. S. Engineer Office at Clewiston, Fla.

JAMES C. OGDEN has been promoted from the position of vice-president of the New York Office of the Robert W. Hunt Company, Engineers, of Chicago, Ill., to that of president and general manager of the Chicago office of the same organization.

CURRY E. FORD, formerly sanitary engineer for the Ohio State Planning Board, is now in the employ of George B. Gascoigne, consulting sanitary engineer of Cleveland, Ohio.

EDWIN J. CORE is now with the Metropolitan Water District of Southern California, with headquarters in Glendale, Calif. He was formerly in the Soil Erosion Service of the Department of the Interior.

F. M. RANDLETT is now vice-president and general manager of the Robert W. Hunt Company, of Chicago, Ill. Formerly he was Pacific Coast manager for the organization at San Francisco, Calif.

JOHN R. HASWELL has been promoted from the position of associate professor in charge of engineering extension at Pennsylvania State College to the rank of full professor in the same department.

GEORGE A. GREENE, formerly assistant resident engineer of the California State Bridge Department, has accepted a connection as assistant bridge construction engineer on the San Francisco–Oakland Bay Bridge.

G. H. HICKOX has resigned from the engineering staff of the University of California to accept a position as hydraulic engineer with the Tennessee Valley Authority, in Knoxville, Tenn.

E. M. FLEMING has been appointed district manager of the Portland Cement Association in charge of the New York Office. For the past six years he has been manager of the Highways and Municipal Bureau of the General Office of the same association in Chicago.

Changes in Membership Grades

Additions, Transfers, Reinstatements, Deaths, and Resignations

From March 10 to April 9, 1935, Inclusive

Additions to Membership

Amthor, Fred Paul (Assoc. M. '34), Constr. Engr., Procurement Div., Public Works Branch, Treasury Dept., 550 New Post Office Bldg., Dallas, Tex.

Baer, Willard Arthur (Jun. '35), Draftsman, U. S. Eng. Office (Res., 3601 Askew Ave.), Kansas City, Mo.

Boguslavsky, Boris William (Jun. '34), 4541 Nineteenth Ave., N. E., Seattle, Wash.

Boysen, Albert Peter (M. '35), Structural Designer and Engr., Am. Bridge Co., 208 South La Salle St., Chicago (Res., 174 Evergreen Ave., Elmhurst), Ill.

Butkiewicz, Joseph Wallace (Jun. '35), 112 Seventh St., New York, N.Y.

Cochran, Donald Sturgeon (Jun. '35), 3200 Ferndale Ave., Baltimore, Md.

Conard, Raymond Foss (Jun. '34), 3230 Chestnut St., Philadelphia, Pa.

Conole, Clement Vincent (Jun. '34), Engr. and Foreman, U. S. Dept. of Interior (Res., 99 Schubert St.), Binghamton, N.Y.

de Chelminski, Vladimir (Assoc. M. '35), Engr., Ministry of Public Works of Venezuela, Ocumare de la Costa, Venezuela.

Dysland, Lloyd Sanders (Jun. '34), 146 Langdon St., Madison, Wis.

Earle, Harold Baldwin (Assoc. M. '35), With Ford, Bacon & Davis, Inc., 39 Broadway, New York, N.Y. (Res., 21 Arcularius Terrace, Maplewood, N.J.)

Foehrenbach, Frank Augustus (Jun. '35), Asst. Engr., Works Div., Dept. of Public Welfare, Flushing (Res., Fort Totten), N.Y.

Getz, Murray Austin (Jun. '34), With Black & Veatch Eng. Co. (Res., 3649 Bales Ave.), Kansas City, Mo.

Godfrey, James Emmason (Jun. '34), 395 Westminister Rd., Brooklyn, N.Y.

Gruss, John Godfrey (Assoc. M. '35), Asst. Engr., Albright & Friel, Inc. (Res., 4638 North 13th St.), Philadelphia, Pa.

Henderson, Russell Stewart (Assoc. M. '35), Engr., National Capital Parks, Eastern Branch (Res., 1400 New Hampshire Ave., N. W.), Washington, D.C.

Hill, Leland Kerr (Jun. '35), Junior Civ. Engr., U. S. Forest Service, Ogden, Utah.

Hinds, Chester Macon (Assoc. M. '35), Dist. Engr., Kalman Steel Corporation, Boston (Res., 4 Gay Rd., Watertown), Mass.

Hunting, Alden Dinsmore (Assoc. M. '34), Associate Constr. Engr., Bridge Dept., State Div. of Highways, 500 Sansome St., San Francisco (Res., 1175 Cleveland St., Redwood City), Calif.

Johnson, Joe William (Jun. '35), Gage Reader, U. S. Waterways Experiment Station (Res., 2602 Drummond St.), Vicksburg, Miss.

Jordan, Thomas Andrew (M. '35), Chf. Designing Engr., Am. Bridge Co., 208 South La Salle St. (Res., 5157 Hutchinson St.), Chicago, Ill.

Ketchum, Daniel Reading (Jun. '35), 813 Second Ave., South, Glasgow, Mont.

Koletty, John William (Jun. '34), Amenia, N.Y.

Krantz, Leon (Jun. '33), Testing Engr., Civ. Eng. Laboratories, Columbia Univ. (Res., 28 Sickles St.), New York, N. Y.

Kristal, Elihu (Jun. '34), Asst., The Highway Materials Testing Laboratory, Brooklyn Polytechnic Inst. (Res., 1840 West 10th St.), Brooklyn, N.Y.

Lepp, John (Jun. '35), 751 East 49th St., Brooklyn, N.Y.

Little, William Seelye (Jun. '35), Asst. Supt., TERA, Civ. Works Administration and Genesee State Park Comm. (Res., 111 Plymouth Ave., South), Rochester, N.Y.

Martin, Harold Judson (Jun. '34), Asst. to Engr. of Maintenance and Operation, Bureau of Eng., City of Los Angeles (Res., 5501 Berkshire Drive), Los Angeles, Calif.

Mitchell, Sterling Ross (Assoc. M. '35), Asst. Div. Engr., State Highway Dept., Box 472, El Paso, Tex.

Molero, Federico (Jun. '35), Abascal, 24, Madrid, Spain.

Neal, Russell Bierer (Jun. '35), 3731 Spruce St., Philadelphia, Pa.

Nutley, Van Eaton (Jun. '34), Route 3, Box 313, Yakima, Wash.

Rich, Charles Carlyle (Jun. '35), Engr., Emergency Relief Administration, Box 166, Nephi, Utah.

Ross, Arthur Reid (M. '34), Associate to Pres., Board of Public Service, City of St. Louis, 304 City Hall, St. Louis, Mo.

Russell, Garfield Hugh (M. '35), Engr. Appraiser, Federal Land Bank of Berkeley, 15th and Clay Sts. (Res., 402 Sixty-Second St.), Oakland, Calif.

Sandvos, Sidney Hale (Jun. '33), Junior Engr., U. S. Bureau of Reclamation, Customhouse, Denver, Colo.

Schoeller, Charles Philip (Jun. '35), Structural Engr. (Deuel & Schoeller) (Res., 257 South Spring St.), Los Angeles, Calif.

Shore, Franklin Kuannien (Assoc. M. '35), Engr., Logan & Amps, 8A Des Voeux Rd. (Res., 34 Village Rd.), Hongkong, China.

Smith, Jack Edward (Jun. '34), 35 South Windsor Ave., Atlantic City, N.J.

Stankewich, Michael Joseph (Jun. '35), 116–12 One Hundred and Twenty-Eight St., South Ozone Park, N.Y.

Teufel, George Illingsworth (Jun. '34), Reedsport, Ore.

Thum, Charles Theodore (Jun. '34), 18 Louise St., Garfield, N.J.

Wallace, Keith Kerney (Jun. '35), Insp. Engr., U. S. Engrs. (Res., 3408 Hardesty St.), Honolulu, Hawaii.

Zuvich, Thomas Joseph (Jun. '34), 135A Twenty-Fourth St., Brooklyn, N.Y.

Membership Transfers

Arenander, Carl Alfred (Jun. '30; Assoc. M. '35), Asst. Engr., Malcolm Pirnie, 25 West 43d St., New York, N.Y. (Res., 108 North 6th St., Newark, N.J.)

Barrett, Berton Arthur (Jun. '27; Assoc. M. '34), Associate Prof., Civ. Eng., Chiao-Tung Univ.; Structural Engr., Malcolm & Co., Ltd. (Res., 289/3 Rue Maresca), Shanghai, China.

Bolieau, Clifton Williams (Jun. '30; Assoc. M. '35), Asst. Engr., Malcolm Pirnie, 25 West 43d St., New York, N.Y.

Evans, Somerby Rogers (Jun. '26; Assoc. M. '35), Asst. Engr., Production Dept., Atmospheric Nitrogen Corporation, Hopewell (Res., 1578 Brandon Ave., Petersburg), Va.

Fisher, James Clarence (Jun. '23; Assoc. M. '34), Asst. Div. Engr., New York and Queens Elec. Light and Power Co., 40–22 Lawrence St. (Res., 23 Oswald Court, Rockville Centre), N.Y.

Gay, Howard Spooner (Assoc. M. '10; M. '35), Engr. Examiner and Executive Secy., Technical Board of Review, PWA (Res., 1703 Q St., N. W.), Washington, D.C.

Hodges, Richard McKandlish (Assoc. M. '24; M. '35), Asst. Engr., Design Div., Eng. Dept., Westchester County Park Comm., White Plains (Res., 22–77 Nineteenth St., Long Island City), N.Y.

Koenig, Edward Francis (Jun. '28; Assoc. M. '35), Junior Civ. Engr., City of Los Angeles (Res., 621 East 25th St.), Los Angeles, Calif.

Livingston, Penn Poore (Assoc. M. '27; M. '35), Associate Engr., Div. of Ground Water, U. S. Geological Survey, Washington, D.C.

Lundy, Thomas Emmett (Jun. '29; Assoc. M. '35), Asst. Engr., H. L. Thackwell, Tyler (Res., 209 East Cotton St., Longview), Tex.

McCurdy, Horace Winslow (Assoc. M. '26; M. '35), Pres. and Gen. Mgr., Puget Sound Bridge & Dredging Co., 2929 Sixteenth Ave., S. W., Seattle, Wash.

Mendez, Enrique (Jun. '30; Assoc. M. '35), Civ. Engr., Compañia Azucarera del Toa, Central Constancia, Toa Baja, Puerto Rico.

Morse, Clinton (Jun. '31; Assoc. M. '34), Junior Engr., The Panama Canal, Box 177, Balboa Heights, Canal Zone.

Reese, George Adam (Assoc. M. '27; M. '35), Cons. Engr., 360 Clark Bldg., Canton, Ohio.

Rodio, Giovanni (Assoc. M. '25; M. '35), Cons. Engr., Corso Venezia 14, Milan (3), Italy.

Sawyer, Robert William, 3d (Jun. '31; Assoc. M. '35), Asst. Engr., Malcolm Pirnie, 25 West 43d St., New York, N.Y.

Smith, Stanley Rinear (Assoc. M. '25; M. '34), With J. G. Brill Co. (Res., 6358 Ross St., Germantown), Philadelphia, Pa.

Thatcher, John Robert (Jun. '28; Assoc. M. '35), Associate Engr., Fort Peck Engr. Dist., U. S. Engrs. (Res., 616 Cheyenne St.), Fort Peck, Mont.

Wachter, Frank Clement (Jun. '31; Assoc. M. '35), Office Engr., Henry G. Perring Co. (Res., 5013 Harford Rd.), Baltimore, Md.

Winter, Carroll Cornelius (Jun. '29; Assoc. M. '35), Associate Bridge Constr. Engr., San Francisco–Oakland Bay Bridge, 500 Sansome St. (Res., 1905 Laguna St.), San Francisco, Calif.

TOTAL MEMBERSHIP AS OF APRIL 9, 1935

Members	5,682
Associate Members	6,108
Corporate Members	11,790
Honorary Members	18
Juniors	3,064
Affiliates	99
Fellows	2
Total	14,973

Reinstatements

Barnett, Ralph Pitcairn, Assoc. M., reinstated Mar. 14, 1935.

Berglund, Gustaf Eric, Assoc. M., reinstated Mar. 15, 1935.

Bowen, John Edmund, Jun., reinstated April 1, 1935.

Embury, Aymar, II, M., reinstated Mar. 11, 1935.

Evans, Arthur Wyndham, Assoc. M., reinstated Mar. 11, 1935.

Hoffman, Abram Zane, M., reinstated April 5, 1935.

McLaughlin, Thomas Perry, Jr., Jun., reinstated April 1, 1935.

PUTNAM, CHARLES EDGAR, M., reinstated Mar. 25, 1935.

SAVIDGE, SAMUEL LEIGH, Assoc. M., reinstated Mar. 25, 1935.

SCHMIDT, FREDERICK ADAM, Jun., reinstated Mar. 28, 1935.

WARDLAW, JOSEPH GEORGE, JR., Assoc. M., reinstated April 1, 1935.

WATERBURY, CLARENCE LESLIE, Jun., reinstated Mar. 11, 1935.

RESIGNATIONS

BENFIELD, ABEL MORRIS, M., resigned April 1, 1935.

COOK, ALBERT CARLTON, Assoc. M., resigned April 1, 1935.

DOTY, ROBERTS OSBORN, Jun., resigned April 1, 1935.

GRIEST, MAURICE, M., resigned Mar. 22, 1935.

KNAP, HANS JORGEN, Jun., resigned April 1, 1935.

KURASHIGE, TETSUZO, M., resigned Mar. 18, 1935.

NARDELLI, DANTE, Jun., resigned Mar. 26, 1935.

NELSON, WALTER NICHOLAS, Assoc. M., resigned Mar. 12, 1935.

TOWNSEND, JOSEPH BOYER, M., resigned April 8, 1935.

DEATHS

BARON, EDWARD VAHAN. Elected Assoc. M., Aug. 31, 1915; M., Nov. 10, 1920; died Dec. 11, 1934.

BROWN, THERON MCCABE. Elected Assoc. M., Nov. 12, 1928; died Mar. 3, 1935.

CONNELL, HENRY LEO. Elected Assoc. M., Jan. 4, 1910; died Mar. 25, 1935.

CORNELIUS, ERNEST HARRY. Elected Assoc. M., July 11, 1921; died May 1934.

FURLOW, FELDER. Elected Assoc. M., April 6, 1909; M., Nov. 26, 1918; died Mar. 5, 1935.

LAMB, ERNEST AVERY. Elected Assoc. M., Sept. 7, 1904; M., Sept. 9, 1919; died Feb. 1, 1935.

MCKENNEY, CHARLES ALBERT. Elected Jun., Dec. 4, 1894; Assoc. M., Dec. 1, 1897; M., Mar. 2, 1909; died Mar. 1935.

MELIN, OSCAR WILLIAM. Elected Jun., Dec. 3, 1913; Assoc. M., Oct. 14, 1919; died Mar. 29, 1935.

MEYER, HENRY CODDINGTON. Elected Fellow, Oct. 22, 1885; died Mar. 27, 1935.

MORRIS, MARSHALL. Elected M., Feb. 1, 1910; died Mar. 24, 1935.

MUNROE, HERSEY. Elected Assoc. M., Mar. 5, 1902; died Feb. 17, 1935.

OBER, HENRY ISAAC. Elected M., Feb. 6, 1912; died Mar. 20, 1935.

PETTEE, EUGENE EVERETT. Elected Assoc. M., Sept. 3, 1902; M., Mar. 2, 1909; died Mar. 17, 1935.

POLING, GUY S. Elected Assoc. M., Aug. 30, 1926; died Mar. 13, 1935.

ROAKE, STEPHEN ALLEN. Elected Assoc. M., June 6, 1911; M., Mar. 13, 1917; died Feb. 1935.

ROSENBERG, THEODORE. Elected M., Jan. 4, 1910; died April 3, 1935.

SMITH, EDWARD KING. Elected Jun., Nov. 4, 1914; Assoc. M., Sept. 10, 1923; died Mar. 9, 1935.

THOMAS, WILLIAM JOHN. Elected M., Feb. 4, 1913; died Jan. 1, 1935.

VOORHEES, ISAAC SPURR. Elected Assoc. M., June 24, 1914; M., April 7, 1930; died Mar. 14, 1935.

WILSON, HENRY FELIX. Elected Assoc. M., April 2, 1902; M., May 2, 1905; died Mar. 2, 1935.

YONGE, SAMUEL HUMPHREYS. Elected M., May 5, 1880; died Mar. 11, 1935.

Applications for Admission or Transfer

Condensed Records to Facilitate Comment of Members to Board of Direction

May 1, 1935 NUMBER 5

The Constitution provides that the Board of Direction shall elect or reject all applicants for admission or for transfer. In order to determine justly the eligibility of each candidate, the Board must depend largely upon the membership for information.

Every member is urged, therefore, to scan carefully the list of candidates published each month in CIVIL ENGINEERING *and to furnish the Board with data which may aid in determining the eligibility of any applicant.*

It is especially urged that a definite recommendation as to the proper grading be given in each case, inasmuch as the grading must be based upon the opinions of those who know the applicant personally as well as upon the nature and extent of his professional experience. Any facts derogatory to the personal character or professional reputation of an applicant should be promptly communicated to the Board.

Communications relating to applicants are considered strictly confidential.

The Board of Direction will not consider the applications herein contained from residents of North America until the expiration of 30 days, and from non-residents of North America until the expiration of 90 days from the date of this list.

MINIMUM REQUIREMENTS FOR ADMISSION

GRADE	GENERAL REQUIREMENT	AGE	LENGTH OF ACTIVE PRACTICE	RESPONSIBLE CHARGE OF WORK
Member	Qualified to design as well as to direct important work	35 years	12 years*	5 years of important work
Associate Member	Qualified to direct work	27 years	8 years*	1 year
Junior	Qualified for sub-professional work	20 years†	4 years*	
Affiliate	Qualified by scientific acquirements or practical experience to cooperate with engineers	35 years	12 years*	5 years of important work
Fellow	Contributor to the permanent funds of the Society			

* Graduation from an engineering school of recognized reputation is equivalent to 4 years of active practice.

† Membership ceases at age of 33 unless transferred to higher grade.

The fact that applicants refer to certain members does not necessarily mean that such members endorse.

FOR ADMISSION

BALOFF, NICHOLAS BORIS, San Francisco, Cal. (Age 33.) Jun. Highway Bridge Engr., U. S. Bureau of Public Roads. Refers to A. A. Clausen, J. L. Mathias, C. C. Morris, R. Pearson, G. D. Whittle.

BATES, CLYDE NOBLE, San Antonio, Tex. (Age 38.) Sales Engr., Republic Cement Co. Refers to F. L. Bramlette, C. A. Clark, J. T. L. McNew, J. M. Nagle, A. P. Rollins, T. B. Warden.

BERMAN, BENJAMIN, New York City. (Age 36.) Deputy Chf. Engr., Triest Contr. Corporation. Refers to J. I. L. Hogan, A. N. Johnson, S. S. Steinberg, F. W. Stiefel, W. G. Triest.

BURRITT, EDWIN WHEELER, Cheyenne, Wyo. (Age 47.) State Engr. of Wyoming. Refers to H. D. Comstock, J. A. Elliott, W. H. Fisher, R. Follansbee, R. D. Goodrich, N. C. Grover, E. Mead, E. K. Nelson, C. G. Paulsen, Z. E. Sevison.

CAPELLE, ERNEST ANDREW, West Haverstraw, N.Y. (Age 24.) Cultural Foreman with John J. Tamsen at Bear Mountain Park, Iona Island, N.Y. Refers to R. A. Hall, L. G. Holleran, H. Miller, W. C. Taylor.

CAPUTO, BENJAMIN GEORGE, New York City. (Age 25.) Engr. with City of New York. Refers to W. R. Bascome, F. J. Bonini, J. F. Krakauer, C. T. Schwarze, D. S. Trowbridge.

CARRIER, CHARLES ROBERT, Kansas City, Mo. (Age 54.) Chf. Superv. Inspector, Dept. of Public Works. Refers to A. E. Barnes, S. J. Callahan, D. M. Dodds, H. A. Fitch, J. C. Long.

CHIARITO, AMERICO THEODORE, New York City. (Age 22.) Refers to W. Allan, R. E. Goodwin, F. O. X. McLoughlin, J. S. Peck, J. C. Rathbun.

CHILDS, BENJAMIN O'CONNOR, Houma, La. (Age 49.) Associate Agri. Engr., Bureau of Agri. Eng., U. S. Dept. of Agriculture. Refers to H. Austill, G. R. Boyd, L. A. Jones, S. H. McCrory, G. N. Mitcham, B. W. Pegues.

CIUFI, HARRY AURELIUS, San Francisco, Cal. (Age 41.) Res. Engr. Inspector, Inspection Div., FEA of PW. Refers to O. E. Carr, R. F. Edwards, G. C. Haun, M. M. Lewis, R. Smillie, E. Welle, L. S. Whippen.

CUSHMAN, ROBERT ELLIS, Portland, Ore. (Age 51.) Sales Engr., Detailer and Consultant, Chas. R. McCormick Lumber Co., Creosoting Dept. Refers to J. P. Newell, H. E. Plummer, C. W. Raynor, O. E. Stanley, R. R. Tinkham, R. B. Wright.

DEMBOSKI, HENRY, Columbus, Ohio. (Age 26.) Jun. Hydr. Engr., U. S. Geological Survey. Refers to L. Lee, C. T. Morris, C. E. Sherman, C. V. Youngquist.

FORTSON, EUGENE PALMER, JR., Vicksburg, Miss. (Age 28.) Jun. Engr., U. S. Waterways Experiment Station. Refers to J. T. L. McNew, H. A. Sargent, R. A. Sturgeon, C. P. Wright.

FREDERICK, HARRY ARTHUR, Orange, N.J. (Age 33.) Laboratory (Testing) Asst., Public Service Elec. & Gas Co., Irvington, N.J. Refers to F. E. Caspar, H. N. Cummings, A. F. Eschenfelder, H. W. Heilmann, W. S. LaLonde, Jr.

FRIBERG, BENGT FRITHIOF, St. Louis, Mo. (Age 32.) Engr., Laclede Steel Co. Refers to E. D. Dryfoose, H. J. Gilkey, C. A. Koerner, F. E. Richart, E. O. Sweetser.

GIANNINI, AMERIGO, Albuquerque, N.Mex. (Age 23.) Jun. Draftsman, New Mexico State Highway Dept. Refers to W. K. Hatt, W. J. Henderson, W. E. Howland, G. E. Lommel, J. H. Matthews, A. P. Poorman, G. P. Springer.

GOULD, CARL ALVORD, Denver, Colo. (Age 51.) Asst. Regional Engr., Eng. Dept., U. S. Forest Service. Refers to J. L. Brownlee, E. H. Dauchy, E. B. Debler, R. Follansbee, M. C. Hinderlider, E. H. Thwaits, R. J. Tipton.

HANER, NORMAN WINFIELD, Portland, Ore. (Age 32.) Asst. Engr., U. S. Engrs., War Dept. Refers to M. E. Clark, L. M. Grant, E. B. Hussey, J. Jacobs, F. E. Leefe, C. C. More, R. M. Murray, W. F. Way.

HASKELL, FRANK HAMPTON, Columbia, S.C. (Age 56.) State Engr., SCERA. Refers to J. H. Dingle, A. E. Johnson, J. M. Johnson, T. K. Legare, J. H. Pratt, R. L. Sumwalt.

HICKSON, ROBERT EDWARD, Portland, Ore. (Age 51.) Senior Engr., U. S. Engr. Dept. Refers to J. W. Cunningham, C. I. Grimm, H. A. Rands, F. C. Schubert, J. C. Stevens, C. F. Thomas, E. B. Thomson.

HOBONJEFF, ROBERT, Calexico, Cal. (Age 21.) With U. S. Bureau of Reclamation, on location surveys, All American Canal Project. Refers to R. E. Davis, C. Derleth, Jr., B. A. Etcheverry, J. H. Fertig, S. T. Harding, C. G. Hyde, F. H. Tibbetts, G. E. Troxell.

HORTON, JOHN, Harrisburg, Pa. (Age 25.) Jun. Engr., U. S. Geological Survey. Refers to B. L. Bigwood, N. C. Grover, A. H. Horton, J. C. Hoyt, L. Lee, J. W. Mangan, C. G. Paulsen.

HOSKINSON, CARL MCKEE, Sacramento, Cal. (Age 49.) Chf. Engr., Div. of Water and Sewers, Eng. Dept., City of Sacramento. Refers to C. R. Blood, E. N. Bryan, D. R. Cate, A. Givan, J. W. Gross, E. Hyatt, C. G. Hyde, A. M. Rawn, L. B. Reynolds, J. R. Shields, H. M. Stafford, T. E. Stanton, Jr., F. D. Talbot.

HUNT, DUDLEY JOSEPH, Denver, Colo. (Age 34.) Engr., U. S. Bureau of Reclamation. Refers to E. B. Debler, J. R. Iakisch, H. R. McBirney, R. A. Monroe, A. Ruettgers, J. L. Savage, R. D. Welsh.

JOHNSON, ARTHUR DELAFIELD, San Diego, Cal. (Age 27.) With J. H. Davies, Long Beach, Cal. Refers to O. G. Bowen, A. Haertlein, L. J. Johnson, R. J. Kadow, A. A. Sauer.

KRAUSS, WOLFGANG WALTER, Philadelphia, Pa. (Age 34.) Cons. Engr., Kastner & Stonorov. Refers to R. A. Backus, O. H. Gentner, Jr., W. J. Luff, Y. Nubar, H. V. Spurr, A. J. Wilcox.

LINDSO, GUNVALD, Harrisburg, Pa. (Age 34.) With McClintic-Marshall Corporation, Steelton Plant, Steelton, Pa. Refers to L. Van H. Fisher, I. M. Lyse, O. J. Marsten, C. H. Mercer, A. J. Willis.

MACKICHAN, KENNETH ALLEN, Ann Arbor, Mich. (Age 23.) Graduate student, Univ. of Michigan. Refers to H. W. King, C. O. Wisler.

MCARTHUR, THOMAS JOSEPH, Long Island City, N.Y. (Age 26.) Refers to R. Cook, W. D. Kramer, B. Marcus, J. V. Marra, H. E. Phelps, M. K. Snyder.

MCCLURE, JOHN CLARENDON ENGLEBRIGHT, South Pasadena, Cal. (Age 46.) Special Engr., Southern Pacific Co., Los Angeles, Cal., representing Chf. Engr. on Eng. Board, Los Angeles Union Passenger Terminal. Refers to G. W. Corrigan, E. C. Eaton, J. J. Jessup, W. H. Kirkbride, R. W. Lawton, J. C. McClure, G. W. Rear.

MCKEE, HUGH THOMAS PETER, Cohoes, N.Y. (Age 28.) Engr. and Supt., Cohoes Emergency Relief Bureau, Div. of TERA. Refers to L. W. Clark, H. B. Compton, T. R. Lawson.

MARTIN, JAMES BERNARD, City Island, N.Y. (Age 44.) Director, Borough President's TERA activities, Brooklyn, N.Y. Refers to A. E. Clark, W. Heyman, G. L. Lucas, J. Meltzer, J. H. Myers, F. A. O'Hare, G. Paaswell, R. Ridgway, F. A. Rossell, J. A. Ruddy, W. J. Shea.

MILLS, HENRY JOHN, Los Angeles, Cal. (Age 33.) Res. Engr., Metropolitan Water Dist. of Southern California. Refers to A. R. Arledge, G. E. Baker, J. B. Bond, R. B. Diemer, H. G. Matthews.

MOORE, ERNEST ARTHUR, Iowa City, Iowa. (Age 34.) Studying under Indian Government Commonwealth Fund Service Fellowship at Graduate School, Hydr. and Eng. Dept., Univ. of Iowa. Refers to J. W. Howe, F. T. Mavis, A. F. Meyer, C. C. Williams, D. L. Yarnell.

MUSE, LEO JACKSON, Baton Rouge, La. (Age 32.) Instructor, Dept. of Civ. Eng., Louisiana State University. Refers to N. E. Lant, B. W. Pegues, G. P. Rice, R. J. Swart, I. W. Sylvester.

NELSON, ARTHUR MAURICE, Minneapolis, Minn. (Age 26.) Asst. Res. Engr., Minneapolis–St. Paul San. Dist. Refers to A. J. Duvall, W. H. Sleeger, A. M. Steffes.

NOWICKI, LEO JOSEPH, Detroit, Mich. (Age 31.) Drain Commr., Wayne County, Mich. Refers to F. H. Alfred, M. E. Cooley, G. D. Kennedy, L. G. Lenhardt, H. A. Shuptrine.

OBERG, STANFORD WILBUR, Houston, Tex. (Age 42.) Chf. Engr., Humble Oil & Refining Co. Refers to J. H. Bringhurst, C. G. Cappel, R. J. Cummins, R. E. Goss, J. M. Howe, G. H. Lacy, C. D. Marx, W. H. Mead, A. A. Stiles.

PETTUS, LESLIE ALEXANDER, St. Louis, Mo. (Age 41.) Div. Civ. Engr., City of St. Louis, Mo. Refers to W. R. Crecelius, H. E. Frech, R. P. Garrett, W. P. Hatfield, C. W. S. Sammelman, R. A. Willis.

PILLET, FREDERICK FISCHER, Baton Rouge, La. (Age 52.) Associate Prof. of Civ. Eng., Louisiana State Univ. Refers to W. B. Gregory, J. R. Peavy, B. W. Pegues, E. O. Sweetser, T. H. Wiggin, W. C. Youngs.

POLISSON, PAUL ANGEL, Gloucester, Mass. (Age 28.) City Engr. Refers to E. W. Bowler, G. W. Case, A. W. Dean, R. R. Skelton.

PRATT, ALMA, Salt Lake City, Utah. (Age 22.) Engr., FERA, Utah Land-Water Use Survey Project, Washington County. Refers to G. D. Clyde, O.W. Israelsen, H.R. Kepner, R.B. West.

QUIRK, WILLIAM HENRY, Flushing, N.Y. (Age 28.) Chf. Computor, New York City Parks Dept., Borough of Queens. Refers to T. T. Davey, A. E. Howland, W. K. Koch, R. P. Lent, C. W. Post, S. Shapiro, E. W. Wolf.

REAMS, SANFORD NEWTON, Columbus, Ohio. (Age 25.) Jun. Hydr. Engr., U. S. Geological Survey. Refers to E. F. Coddington, L. Lee, J. C. Prior, C. E. Sherman, C. V. Youngquist.

ROAKE, THEODORE CHESTER, Salem, Ore. (Age 30.) Designer, Oregon State Highway Comm. Refers to J. L. Franzen, C. B. McCullough, G. S. Paxson, R. T. Stanley, F. T. Young.

ROBINSON, PAUL THOMPSON, Oakland, Cal. (Age 53.) Engr., M. of W. and Structures, Southern Pacific Co., San Francisco, Cal. Refers to J. Q. Barlow, C. R. Harding, W. H. Kirkbride, H. McDonald, T. S. O'Connell, G. W. Rear, W. F. Turner.

ROLFSEN, ALF JUSTIN, New York City. (Age 27.) Engr. and Supt. of Constr., New York Park Dept., Topographical Div. Refers to E. J. Carrillo, E. G. Reynolds, C. T. Schwarze, D. S. Trowbridge, J. Wilmot.

ROSOV, IVAN, New York City. (Age 52.) Designer, Delaware, Lackawanna & Western R.R. Refers to W. O. Fremont, H. Gutman, S. P. Maximoff, L. S. Moisseiff, V. K. Ostoia, V. V. Tchikoff, P. von Weymarn.

RUSS, ALEXANDER, Highland Park, Mich. (Age 26.) Refers to W. K. Hatt, W. J. Henderson, G. E. Lommel, G. P. Springer.

SCHIFF, LEONARD, Santa Paula, Cal. (Age 23.) Jun. Agri. Engr., Soil Erosion Service, Dept. of Agriculture. Refers to C. Derleth, Jr., F. S. Foote, C. G. Hyde, B. Jameyson, H. E. Reddick.

SMITS, HOWARD GARDNER, Beverly Hills, Cal. (Age 25.) Designer with C. Deuel, Los Angeles, Cal. Refers to O. G. Bowen, F. J. Converse, R. R. Martel, F. Thomas.

SPATH, PAUL CHRISTIAN, Columbus, Ohio. (Age 26.) Jun. Hydr. Engr., U. S. Geological Survey. Refers to E. F. Coddington, N. C. Grover, L. Lee, J. M. Montz, C. E. Sherman, C. V. Youngquist.

SPIELVOGEL, SIEGFRIED WERNER, Brooklyn, N.Y. (Age 42.) Supervisor with Brooklyn Edison Co. Refers to C. E. W. Pantke, J. C. Riedel, M. A. Rifkinson, D. B. Steinman, L. S. Stiles, A. S. Tuttle.

TAROF, ERNEST LIVINGSTON, Brooklyn, N.Y. (Age 43.) Member of firm, Kerlow Steel Flooring Co., Jersey City, N.J. Refers to W. O. Barkley, D. Bonner, E. W. Denzler, Jr., M. Goodkind, S. Hardesty, C. Kendall, J. A. L. Waddell.

TAYLOR, COLIN ALEXANDER, Pomona, Cal. (Age 35.) Asst. Irrigation Engr., Div. of Irrigation, Bureau of Agri. Eng., U. S. Dept. of Agriculture. Refers to H. F. Blaney, S. H. McCrory, W. P. Rowe, F. C. Scobey, A. L. Sonderegger, O. V. Stout, H. C. Troxell.

TERRILL, DUDLEY RUSSELL, Lakewood, Ohio. (Age 29.) Asst. Engr., Ohio State Highway Dept., Cleveland, Ohio. Refers to A. A. Brielmaier, G. W. Hamlin, A Miller, F. H. Neff, F. L. Plummer, G. E. Schumann.

WALSH, JOHN BURKE, Brooklyn, N.Y. (Age 39.) Structural Draftsman Grade 4, Dept. of Docks, City of New York. Refers to A. H. Beyer, L. W. Clark, W. T. Doran, C. B. Galvin, M. J. Gruenbaum, T. R. Lawson, J. H. Quimby, E. J. Squire, D. B. Steinman.

WEEBER, RICHARD PAUL, Havana, Ill. (Age 30.) Engr. and Forester, ECW Camp 58-PE (CCC). Refers to C. O. Carey, C. T. Johnston, H. W. King, H. J. McFarlan, T. J. Mitchell.

WUOPIO, FRANS ALBERT, Sacramento, Cal. (Age 32.) Asst. Topographic Engr., U. S. Geological Survey. Refers to L. L. Bryan, W. R. Chenoweth, H. H. Hodgeson, R. R. Monbeck, C. N. Mortenson, J. G. Staack.

FOR TRANSFER

FROM THE GRADE OF ASSOCIATE MEMBER

CLEMENT, EDWARD DAWSON, Assoc. M., Charleston, S.C. (Elected Nov. 11, 1929.) (Age 47.) Clement Constr. Co.; also member of Board of Architectural Review under zoning ordinance for city of Charleston. Refers to J. H. Dingle, H. P. Eddy, Jr., J. E. Gibson, J. M. Johnson, B. M. Thomson.

COOLEY, HENRY BELL, Assoc. M., New Orleans, La. (Elected July 14, 1930.) (Age 36.) Asst. State Engr., ERA. Refers to D. Derickson, A. T. Dusenbury, W. B. Gregory, J. Klorer, F. A. Muth, A. M. Shaw, J. D. Walker.

COUGHLIN, ROBERT EMMET, Assoc. M., Rock Island, Ill. (Elected Dec. 16, 1929.) (Age 40.) Capt., Corps of Engrs., U. S. Army; Executive and Disbursing Officer, U. S. Engr. Office. Refers to E. L. Daley, G. E. Edgerton, J. J. Hinman, Jr., A. H. Holt, A. E. Howland, C. S. Jarvis, E. M. Markham, W. J. Shea, H. P. Warren, D. L. Yarnell.

CRANE, ALBERT ELI, Assoc. M., Noroton, Conn. (Elected March 13, 1917.) (Age 44.) Vice-Pres., T. E. Rhoades Co., New York City. Refers to H. G. Balcom, W. W. Chapin, E. L. Daley, N. H. Jones, J. A. Olson, G. E. J. Pistor, W. M. Wolfe.

FRICK, WALTER HIRAM, Assoc. M., Wilkinsburg, Pa. (Elected May 25, 1931.) (Age 38.) Cons. Structural Engr. (Architectural). Refers to M. Brown, W. N. Dambach, P. A. Franklin, A. V. Karpov, F. Kubitz, F. L. Metzger, T. Pealer, F. F. Stager, C. L. Wooldridge.

GAMBLE, RALEIGH WELCH, Assoc. M., Milwaukee, Wis. (Elected Oct. 21, 1924.) (Age 42.) Supt., Bureau of Street Constr. & Repairs, City of Milwaukee. Refers to J. L. Ferebee, R. R. Lundahl, D. W. Townsend, F. E. Turneaure, C. S. Whitney.

GERDES, HENRY GEORGE, Assoc. M., Washington, D.C. (Elected Junior Oct. 2, 1922; Assoc. M. Nov. 11, 1929.) (Age 35.) Engr., Federal Power Comm. Refers to B. A. Etcheverry, J. M. Evans, S. S. Gorman, C. I. Grimm,

D. C. Henny, R. B. McWhorter, H. A. Rands, E. H. Ropes, L. W. Stocker, F. H. Tibbetts, R. G. Wadsworth, J. B. Wells.

Gromfine, John Jacob, Assoc. M., Brooklyn, N.Y. (Elected Jan. 14, 1924.) (Age 39.) Lt. Commander, Corps. of Civ. Engrs., U. S. Navy, Brooklyn Navy Yard. Refers to W. M. Angas, R. E. Bakenhus, J. T. Mathews, B. Moreell, A. L. Parsons, C. D. Thurber.

Herthe, Norman Matthew, Assoc. M., Buffalo, N.Y. (Elected June 4, 1928.) (Age 38.) Member of firm, Ellsworth, Barrows & Co., Civ. Engrs. Refers to G. E. Barrows, E. C. Boehm, C. L. Howell, J. G. Little, E. P. Lupfer, W. A. Rathmann, F. K. Wing.

Johnson, Clifford, Assoc. M., Bismarck, N.Dak. (Elected March 23, 1926.) (Age 35.) Bridge Engr., North Dakota State Highway Comm. Refers to B. Blum, A. Boyd, E. F. Chandler, E. R. Griffin, R. E. Kennedy, W. P. Linton, R. A. Pease.

Leach, Walter Lewis, Assoc. M., Cleveland, Ohio. (Elected Junior Oct. 21, 1924; Assoc. M. March 5, 1928.) (Age 35.) With George B. Gascoigne, Cons. Engr. Refers to A. A. Burger, G. B. Gascoigne, W. L. Havens, R. Hoffmann, G. B. Sowers.

Li, Shu-T'ien, Assoc. M., Tientsin, China. (Elected Junior June 7, 1926; Assoc. M. Oct. 3, 1932.) (Age 35.) Chairman and Chf. Engr. of Comm. for Development of Great Northern Port. Refers to F. A. Barnes, A. G. Hayden, S.-T. Hsu, H. H. Ling, E. W. Schoder, O. J. Todd, L. C. Urquhart, J. A. L. Waddell, T. C. S. Yen.

Loehninger, Ferdinand Truesdell, Assoc. M., New York City. (Elected March 16, 1925.) (Age 46.) Fish & Loehninger, Cons. Engrs. Refers to D. W. Coe, C. Mayer, R. Owen, A. W. Stephens, W. J. Thomas, W. Wilson.

Olafsen, Reidar, Assoc. M., Longacre, W.Va. (Elected July 25, 1932.) (Age 35.) Designing Engr., New Kanawha Power Co., Glen Ferris, W.Va. Refers to C. S. Bissell, L. H. Davis, M. Goodkind, T. D. B. Groner, O. M. Jones, A. Lundgren, C. A. Melick.

Pollard, Charles Jasper, Assoc. M., Buffalo, N.Y. (Elected June 4, 1928.) (Age 44.) Member of firm, Ellsworth, Barrows & Co., Engrs. Refers to G. E. Barrows, R. L. Fox, T. Green, J. G. Little, E. P. Lupfer, N. H. Sturdy.

Rucquoi, Leon Guillaume, Assoc. M., Brussels Belgium. (Elected Feb. 27, 1933.) (Age 35.) Executive Director, Le Centra belgo luxembourgeois d'Information de l'Acier. Refers to H. K. Barrows, F. H. Frankland, G. E. J. Pistor, C. M. Spofford. (Applies in accordance with Sec. 1, Art. 1, of the By-Laws.)

Schroeder, Frank Charles, Assoc. M., Milwaukee, Wis. (Elected Sept. 3, 1912.) (Age 52.) Chf. Draftsman, Way and Structures Dept., The Milwaukee Elec. Ry. & Light Co. Refers to J. L. Ferebee, L. M. Hammond, C. F. Loweth, R. R. Lundahl, C. C. More, C. U. Smith, F. E. Turneaure.

Sherlock, Robert Henry, Assoc. M., Ann Arbor, Mich. (Elected March 16, 1925.) (Age 48.) Prof., Eng. Coll., Univ. of Michigan. Refers to J. H. Cissel, L. M. Gram, W. C. Hoad, H. W. King, F. S. Merrill, H. E. Riggs, A. H. Smith.

Stuart, James Lyall, Assoc. M., Pittsburgh, Pa. (Elected Junior Oct. 4, 1898; Assoc. M. Feb. 7, 1900.) (Age 62.) Constr. Engr. Refers to G. S. Davison, F. S. Greene, C. M. Reppert, M. R. Scharff, P. M. Tebbs.

van den Berg, Cornelius, Jr., Assoc. M., Charleston, W.Va. (Elected Junior Feb. 25, 1924; Assoc. M. Nov. 11, 1929.) (Age 35.) Pres., West Virginia, Illinois, and Ohio Water Service Cos. Refers to T. J. Blair, Jr., A. W. Cuddeback, F. P. Larmon, P. L. McLaughlin, G. D. Norcom, T. H. Wiggin.

From the Grade of Junior

Cox, Glen Nelson, Jun., Baton Rouge, La. (Elected April 23, 1928.) (Age 32.) Associate Prof., Depts. of Civ. Eng. and Eng. Mechanics, Louisiana State Univ. Refers to M. L. Enger, D. W. Mead, B. W. Pegues, F. E. Richart, S. M. Woodward, D. L. Yarnell.

Goodhue, Howard William, Jun., Pasadena, Cal. (Elected Oct. 12, 1925.) (Age 32.) Asst. Engr., Pasadena Water Dept. Refers to P. Bailey, D. R. McFarland, S. B. Morris, C. E. Pearce, V. L. Peugh, F. Thomas, T. B. Waddell.

Graham, Nathan Jerome, Jun., Williams, Cal. (Elected April 30, 1934.) (Age 32.) Truck Trail Locator, U. S. Forest Service, San Francisco, Cal. Refers to A. E. Crenshaw, B. A. Etcheverry, C. G. Hyde, B. Jameyson, C. L. Young.

Hummer, John William, Jun., Columbus, Ohio. (Elected Oct. 12, 1925.) (Age 32.) Asst. Valuation Engr., The United Light & Power Eng. & Constr. Co., Davenport, Iowa. Refers to J. W. Howe, A. Marston, E. L. Waterman, C. C. Williams, S. M. Woodward, D. L. Yarnell.

Jens, Stifel William, Jun., University City, Mo. (Elected Oct. 24, 1932.) (Age 32.) Asst. Engr. with W. W. Horner, Cons. Engr., St. Louis, Mo. Refers to E. E. Bloss, W. W. Horner, H. Shifrin, E. O. Sweetser, J. L. Van Ornum.

Kane, Clyde Vernon, Jun., San Bernardino, Cal. (Elected Oct. 10, 1927.) (Age 33.) Associate Highway Engr., California Div. of Highways. Refers to F. B. Dauchy, C. Deeleth, Jr., C. H. Lee, C. S. Pope, E. Q. Sullivan.

Lyons, Emanuel, Jr., Jun., Panama, Panama. (Elected March 5, 1928.) (Age 30.) Refers to H. G. Arango, L. Arosemena, E. P. Haw, E. Jaen Guardia, F. R. Molther.

Pollock, Herbert William, Jun., Seattle, Wash. (Elected Oct. 24, 1932.) (Age 29.) Asst. Engr., Washington State Dept. of Public Works, Olympia, Wash. Refers to C. W. Harris, R. M. Harris, D. W. McMorris, C. D. Pollock, L. H. Rubicam, R. G. Tyler.

Reynolds, Thomas George, Jun., Ponca City, Okla. (Elected Oct. 1, 1928.) (Age 29.) Asst. Res. Engr., Continental Oil Co. Refers to J. S. Crandell, J. J. Doland, W. C. Huntington, E. D. McKeague, G. W. Pickels, T. C. Shedd, F. W. Stubbs, Jr.

Rishell, Charles Gerald, Jun., Harrisburg, Pa. (Elected May 25, 1931.) (Age 31.) Engr., Bureau of Eng., Public Service Comm., Refers to C. H. Buckius, W. J. Carroll, E. F. Crosetto, D. M. Griffith, J. W. Hopkins, C. E. Perry, W. J. Rinebold.

Roberts, Fredrick Carlyle, Jr., Jun., Phoenix, Ariz. (Elected April 27, 1931.) (Age 28.) State San. Engr., Arizona State Board of Health. Refers to R. G. Baker, E. S. Borgquist, T. R. Camp, J. A. Fraps, J. B. Girand, R. V. Leeson, G. E. P. Smith.

Sawtelle, Egerton Burpee, Jun., Augusta, Me. (Elected Oct. 24, 1932.) (Age 31.) Jun. Engr., Maine State Highway Comm. Refers to H. L. Bowman, H. L. Doten, H. F. Hill, S. J. Leonard, P. D. Sargent, A. L. Saunders, M. R. Stackpole.

Schofer, August, Jun., Columbus, Ohio. (Elected Jan. 16, 1928.) (Age 32.) Associate Highway Engr., U. S. Bureau of Public Roads. Refers to T. W. Allen, W. V. Buck, R. R. Litehiser, V. N. Peirce, R. N. Waid.

Walker, James Donald, Jun., Aurora, Ill. (Elected Feb. 23, 1932.) (Age 27.) San Engr., The American Well Works. Refers to H. E. Babbitt, F. Bachmann, F. M. Dawson, W. D. Gerber, L. B. Kinsey, I. C. Peterson, G. S. Russell, J. J. Woltmann.

Walter, Carl Emil, Jun., Baltimore, Md. (Elected Oct. 1, 1926.) (Age 32.) Senior Engr., Camp S 52, CCC, Grantsville, Md. Refers to D. H. Dixon, H. O. Sauer, T. A. Smith, S. J. Sprol, A. C. Tozzer, H. C. Turner.

Yasines, Stan Franz, Jun., New York City. (Elected Jan. 14, 1929.) (Age 32.) Instructor in Civ. Eng., New York Univ. Refers to S. N. Grimm, T. Saville, C. T. Schwarze, D. S. Trowbridge, B. L. Weiner.

The Board of Direction will consider the applications in this list not less than thirty days after the date of issue.

Men Available

These items are from information furnished by the Engineering Societies Employment Service, with offices in Chicago, New York, and San Francisco. The service is available to all members of the contributing societies. A complete statement of the procedure, the location of offices, and the fee is to be found on page 87 of the 1935 Year Book of the Society. To expedite publication, notices should be sent direct to the Employment Service, 31 West 39th Street, New York, N.Y. Employers should address replies to the key number, care of the New York Office, unless the word Chicago or San Francisco follows the key number, when it should be sent to the office designated.

Construction

Engineer; Jun. Am. Soc. C.E.; 25; licensed land surveyor; now engineer inspector of waterworks construction; 3 years experience on the construction of bridges, grade-crossing eliminations, retaining walls, station facilities, sewers, pavements, etc. Land and topography surveys. Desires permanent connection with consulting engineer, contractor, or corporation. Available July 1. D-2876.

Construction Engineer; Assoc. M. Am. Soc. C.E.; Wisconsin state license; university graduate; 12 years experience on roads, bridges, walls, making cost reports, surveying, office work, subdivision, supervision, and inspection. Salary or location no object if there is possibility of advancement and some degree of permanency. Available immediately. C-6632.

Construction Engineer; Jun. Am. Soc. C.E.; 32; married; B.S. in C.E., New York University; enrolled Alexander Hamilton Institute business course; 5 years contractor's engineer on costs and construction, bridges, roads, bulkheads, foundations; 4 years with telephone company, as engineer-in-charge, on 50 miles of conduit construction and 35 miles of conduit rearrangement. Desires responsible position with future. C-5622.

Engineer and Superintendent; Assoc. M. Am. Soc. C.E.; graduate C.E.; age 36; 16 years experience in general construction and supervision of construction of hospitals, hotels, theaters, and office buildings. Desires employment with contractor or corporation. Location immaterial. B-5434.

Executive

Graduate Civil Engineer; Assoc. M. Am. Soc. C.E.; registered in two states; 13 years experience; desirous of making connection; 4 years experience in supervision and construction of concrete highways and bridges; 5 years in charge of preliminary surveys and plans for municipal improvements; 4 years experience as construction engineer on large industrial plants, installation of equipment, and preliminary operations. D-1100.